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DATA ACCUMULATION ON THE METHANE POTENTIAL OF THE COAL BEDS OF COLORADO

Prepared for
UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

by
HOLLIS B. FENDER and D. KEITH MURRAY
COLORADO GEOLOGICAL SURVEY

FINAL REPORT ON
GRANT (Contract) NO. G-016608, "Data Accumulation on the Methane Potential of the Coal Beds of Colorado"

Submitted March 31, 1978

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Abstract: A two-year project was conducted to gather data that would assist in the evaluation of the methane potential of the coal beds of Colorado. It was found that a number of closed underground coal mines in the State had reported "gassy" conditions or had experienced fires and explosions of varied intensity and frequency. The majority of such occurrences have been in those areas characterized by coals of relatively low (i.e., below 31%) volatile matter (VM) content. The south half of the Raton Mesa coal region (Las Animas County) and the southeastern part of the Uinta region (in Gunnison and Pitkin Counties) contain coals with the lowest percentages of VM, the gassiest producing mines, and the highest grade coking coal in the State. Five active mines in Pitkin County presently are emitting a total of over 8 million cu ft of methane per day. These mines produce the highest quality metallurgical-grade coal in the western U.S. (high-volatile A and medium-volatile bituminous). The gassy coals in these two regions range from Late Cretaceous to Paleocene in age and usually occur in areas related to igneous activity of late Tertiary age. The VM percentages of Colorado coals can be used, with some caution, to determine their potential methane content. Additional desorption measurements and coal analyses are needed to more accurately predict the effects of rank and depth of occurrence on the methane content of coals in the State.

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FOREWORD

This report was prepared by the Colorado Geological Survey, Department of Natural Resources under USBM Contract number G0166008. The contract was initiated under the Methane Control and Ventilation Program. It was administered under the technical direction of the Pittsburgh Mining and Safety Research Center with Charles M. McCulloch and W. Patrick Diamond as Technical Project Officers, and Maurice Deul as Research Supervisor. Joseph E. Pettus was the contract administrator for the Bureau of Mines. This report is a summary of the work recently completed as a part of this contract during the period October 1, 1975 to December 31, 1977. This report was submitted by the authors on March 31, 1978.

ACKNOWLEDGMENTS

The writers appreciate the cooperation and assistance of many agencies, individuals, and companies during the course of this study. The Federal and State agencies in the Denver area that merit special recognition are the following: Mining Enforcement and Safety Administration (MESA), District 9; U.S. Geological Survey Conservation and Geologic Divisions; U.S. Bureau of Mines Technical Support Center and Intermountain Field Operations Center; and Colorado Division of Mines and Oil and Gas Conservation Commission, Department of Natural Resources.

Too numerous to mention are all of the companies and individuals who provided assistance in a myriad of ways. We are especially grateful to the companies (not specifically named for reasons of confidentiality) that provided the coal cores needed for the project. The helpful cooperation of the following individuals also is gratefully acknowledged: D. H. Hebb and M. S. Curtin, Mineral Economics Research Institute, Colorado School of Mines who compiled considerable data used in the "Colorado Coal Directory"; Philip Eager, U.S. Geological Survey Conservation Division; Robert C. Hobbs, U.S. Geological Survey, Branch of Coal Resources, Denver; and Andrew Deborski, Colorado Division of Mines.

INTRODUCTION

The Department of the Interior, Bureau of Mines, on behalf of the United States of America, granted fifty thousand dollars ($50,000) to the Colorado Geological Survey, Denver, Colorado, in support of a research project entitled "Data Accumulation on the Methane Potential of the Coal Beds of Colorado", to commence on October 1, 1975, under the direction of D. Keith Murray, Chief, Mineral Fuels Section, Colorado Geological Survey.

The objectives of the grant were as follows: (1) To search the literature and available historic records for references pertaining to the occurrence of methane gas in Colorado coal beds and mines; (2) to obtain freshly cut coal cores in order to calculate the methane gas content of the coal by means of desorption measurements; (3) to compile a bibliography of published and unpublished articles on Colorado coal; (4) to acquire geological data needed to prepare stratigraphic cross sections and structure and isopach maps of coal beds in selected areas; and (5) to collect data on faults, fractures, cleats, etc. related to the coal beds studied.

One goal of this project was to locate an area in Colorado in which "gassy" coal beds could be penetrated by a vertically drilled hole and subsequently stimulated by the hydraulic method currently being employed by the petroleum industry to enhance the production of oil and gas. Stimulation treatments of coal beds in other areas of the country have in some instances increased the flow of methane several fold. Degasification of coal beds ahead of mining could result in the development of needed new reserves of pipeline-quality gas, improvement of mine safety, and increased mine productivity.

LITERATURE SEARCH AND BIBLIOGRAPHY

Very little information about methane gas in Colorado coal beds was gleaned from the literature. In fact, only a few references pertaining to coal in Colorado were published from the late 1800's to 1945. Most of the methane gas data for this project were obtained from a publication by H. B. Humphrey (1959). This information is shown on the map entitled, "Methane in Colorado Coal Mines" (Plate 1), and in the accompanying tabulation, "Occurrence of Methane Gas in Colorado Coal Mines" (Table 1).

A good source with which to start a search for references pertaining to methane gas in coal in Colorado is the "Bibliography, Coal Resources in Colorado", compiled by R. D. Holt (1972). After our literature search had begun, Colorado Geological Survey Bulletin 37, "Bibliography and index of Colorado geology, 1875 to 1975", compiled by the American Geological Institute, was published (1976). Bulletin 37 contains a large section devoted to coal; however, it does not replace Holt's (1972) bibliography, which is limited to coal-related publications.

Over 500 articles and publications pertaining to Colorado coal not listed in Bulletin 34-A have been catalogued. This new coal bibliography will be published by the Colorado Geological Survey early in 1978 (Fender, Jones and Murray, 1978). The references pertaining to methane in coal are listed under "methane, explosions, fires" in the key word index section in this new bibliography.

Volatile Matter Content of Coal

The literature search provided only a partial clue regarding the areas in Colorado that might contain the more "gassy" coal beds. The U.S. Bureau of Mines and others theorize that the lower the percentage of volatile matter in coal, the higher the methane content. On the basis of this concept, and on the few references in the literature, the Bureau of Mines requested that all available volatile matter (VM) percentages be plotted on a map.

These data are displayed on the map entitled, "Methane in Colorado Coal Mines" (Plate I). This map shows that parts of two coal regions in Colorado (the Uinta and Raton Mesa) contain some coal beds with relatively low volatile matter content.

Several local areas in the State have deposits of coal with exceptionally low volatile matter content. Two mines in Crested Butte coal field, in Gunnison County, for example, contain coal (anthracite) with approximately 7 percent volatile matter. In the Yampa coal field, the coal from one mine in western Routt County contains 7.3 percent volatile matter (anthracite); and in another mine, coal with 14.6 percent volatile matter was noted. These mines appear to be located near igneous intrusive bodies; thus, the affected areas probably are rather small in areal extent.

Statewide, the percent VM in coal ranges from 6.9 to 44.8, or from anthracite to subbituminous in rank, bituminous being the predominant rank in terms of total resource. In order to delineate the more gassy areas to be studied in detail, an arbitrary VM content of 31 percent is considered to be the upper limit (i.e., the upper limit of medium-volatile bituminous coal; see Table 4). Most of the coal regions in Colorado are characterized by VM contents above 31 percent.

Using the 31 percent VM figure, it appeared to us that the south half of the Raton Mesa region, in Las Animas County, and the southeastern part of the Uinta coal region, in Garfield, Mesa, Delta, Pitkin, and Gunnison Counties (southeastern Piceance Creek basin), were the two prime areas warranting further study.

Methane Occurrence

The tabulation entitled "Occurrence of Methane gas in Colorado Coal Mines" (Table 1) shows only the major mine explosions and fires. According to Humphrey (1959), there have been many minor explosions in coal mines in the United States. Table 1 shows mine name and location, coal bed name and thickness, overburden thickness, coal rank, current MESA

methane emission data from active mines, average VM percentages from coal analyses, and the nature of the occurrences of methane in mines (i.e, whether "gassy mines", explosions, fires, etc.).

The data pertaining to gas explosions, dust explosions, mine fires, and the like were placed on the map (Plate 1) alongside the appropriate mine locations; however, these data did not clearly delineate the gassier areas of the coal regions in the State, as had been anticipated. It should be emphasized that even a "low" gas mine can be dangerous if mine ventilation is inadequate.

The average daily emissions of methane gas, measured in cubic feet, and the daily production of coal from the active mines were of considerable value to our project. The active coal mines in the State, some of which are included in the tabulation, are checked periodically by the Mining Enforcement and Safety Administration (MESA), District 9 Mine Inspection Office. MESA has provided data on the average tons of coal mined per day as well as the volume of gas being liberated per day. The cubic feet of gas emitted per ton of coal mined can then be calculated using these data. It should be noted that not all of the methane emitted by a mine comes directly from the coal being mined. Gas also emits from the exposed ribs (sides) and sometimes from the roof and floor rocks in a mine.

A study of the active coal mines in Pitkin County shows that the cubic feet of gas emitted per ton of coal mined ranges from 159 to 4,060 (Table 1). Five of these mines (Bear Creek, Coal Basin, Dutch Creek #1 and #2, and L.S. Wood), are among the gassiest coal mines in the United States (Irani and others, 1977). This is true only when compared with other mines in the United States on the basis of cubic feet of gas emitted per ton of coal mined. The latest gas measurements shown on Table 1 were taken during the first quarter of 1977.

Desorption of Coal Cores

Probably the most important facet of this grant was to determine the cubic feet of methane gas per ton of in-place coal in as many coal beds as possible in each of the coal-bearing regions in Colorado. This phase of the project necessitated contacting all of the companies that are now, or in the future might be, actively involved in coal exploration, especially in the coring of coal.

The search revealed that information concerning the names of coal companies operating in Colorado, proposed coal mines, and coal exploration projects was either sketchy or not readily available.

The established coal industry in Colorado, as well as new companies becoming involved in coal exploration in the State, needed to be informed of the various coal grants and related coal projects being conducted by the Colorado Geological Survey.

In order to distribute this information, a form letter was composed giving a brief review of each of the coal grants and of the proposed Colorado Coal Directory (Form No. 1). This letter, together with two

attached forms, "Producing/Licensed Coal Mine Data Sheet" (Form 3), and "Proposed Coal Mine Data Sheet" (Form 4), were sent to over 65 companies and individuals in Colorado. A more detailed form letter (Form 2) describing the nature of the methane project was mailed to many companies and individuals.

What at first appeared to be a simple task was complicated by changing company exploration programs, reluctance of some companies to cooperate with the Colorado Geological Survey and the U.S. Bureau of Mines, and the small amount of coring being conducted or planned in some of the coal regions.

Methane Desorption Method

The method used for desorption of the coal cores is the so-called "direct method" used by the U.S. Bureau of Mines (McCulloch and others, 1975). The intent of this method was to allow the gas content of a coal bed to be measured at the drill site rather than in a laboratory. The direct method is applied to coal cores obtained from vertical boreholes.

The equipment used for desorbing coal cores consists of the following:

1. A plastic or aluminum cannister or cylinder approximately 12 in. in height with an inside diameter of about 4 in. The cannister has a closed bottom and a removable top fitted with an "O" ring seal.

2. A valve and a low-reading pressure gauge threaded into the removable top of the cannister.

3. Plastic hose 2-3 ft in length, with fittings on one end that mesh with the fittings on the valve.

4. A cake pan about 8 in. square and 2 in. deep.

5. A plastic graduated cylinder with milliliter markings.

6. A stand with a clamp to hold the graduated cylinder.

The procedure for using this equipment is as follows:

1. Fill the pan with water and place the open end of the inverted plastic graduated cylinder into and below the water level in the pan. Retain the cylinder in position by using the clamp and stand.

2. Slide the plastic hose into the open end of the cylinder in the water, and push the hose up to the bottom of the cylinder.

3. Suck on the hose in order to draw water into and to fill the cylinder.

4. Remove the hose.

5. Place a portion of a freshly retrived coal core (1000± grams preferred) as quickly as possible into the aluminum cannister and secure the top in place.

6. Connect the fitted end of the hose to the valve.

7. Place the other end of the hose 1-2 in. into the open end of the cylinder immersed in the water.

At 15-minute intervals during the first two hours of desorption, the valve should be opened to permit any free gas contained in the cannister to displace the water in the graduated cylinder. These readings are plotted on a chart in order to establish the amount of gas that had been lost from the time the coal was penetrated by the core bit until it had been sealed in the cannister. This gas is referred to as "lost gas."

Following the first two hours of testing, the valve usually is opened only once every 24 hours to measure the gas being liberated by the core (if considerable gas is being emitted, bleed-off operations may be conducted every hour, or at the discretion of the geologist). The results are plotted on the same chart noted above and are referred to as volume of "desorbed gas." The desorbing process should be continued until the daily methane emission rate drops below 0.05 cm^3.

The desorbed core is then removed from the cannister, sealed in a plastic bag, and shipped to the U.S. Bureau of Mines Pittsburgh (Bruceton) office, where it is crushed in a sealed ball mill in order to measure the "residual" or remaining gas in the core.

By knowing the total amount of gas in the coal sample--lost, desorbed, and residual--and the weight of the coal sample, one may calculate the cubic feet of gas contained in one ton of coal in-place. This information can be used to predict the volume of methane that may be emitted from a prospective mine, which should be invaluable to an operator in planning a mine ventilation system.

During the two-year period of this grant, two procedural changes were made in the core desorption process. The first change involved the formula used to calculate the amount of "lost gas" when a cannister developed a vacuum after it had been moved from the well site to Denver. The second change, made late in July 1977, concerned the method used to obtain the amount of residual gas in a core. The residual gas determination was changed from a graph to a new method developed by the Bureau of Mines whereby the pieces of coal core are crushed to less than 200-mesh in a sealed ball mill and then the volume of gas liberated can be measured directly. To date, four cores have been returned to the Bureau of Mines office in Pittsburgh (Bruceton), Pennsylvania, to be tested for residual gas. These tests have confirmed that a coal can emit considerable gas during the desorbing process and yet retain a significant amount of residual gas (the amount depends upon the character of a particular coal).

In all probability, the reported gas volume for all cores desorbed prior to the initiation of the aforementioned procedural changes is conservative. The result for samples not tested for residual gas using the new method should be considered as minimum values. The methane that is "freely" emitted from a core prior to crushing probably is that which will have the most serious effect on a mining operation.

Another observation pertains to the apparent relationship of the gas desorption results and the volatile matter percentage shown on Plate 1. As previously stated, the higher the percentage volatile matter, the less the amount of gas expected to be retained in the coal. Each of the cores desorbed was obtained from the higher percentage VM areas, and each core released only small amounts of gas, as might be predicted.

In most instances, the portions of the cores obtained for desorption were given to us by the operators with no restrictions on their use. Therefore, the usual procedure followed was to desorb the core, remove it from the cannister, seal it in a plastic bag, and then send it to the U.S. Bureau of Mines Pittsburgh (Bruceton) office for crushing to determine the amount of residual gas. A split of the core then was sent by the Bruceton office to the Department of Energy (formerly Bureau of Mines) analytical laboratory in downtown Pittsburgh for conventional coal analyses. Finally, a split was sent to the U.S. Geological Survey laboratory in Denver for geochemical (including trace elements) analyses.

A copy of the results of the desorption and the analyses have been sent to each company providing the core samples. The desorption data and a summary of the analyses for each core sampled are listed on Table 2.

Results of Desorption Tests

A total of 19 cores have been desorbed to date (Table 2). These cores have been collected from the north half of the Raton Mesa coal region, the west half of the San Juan River region, the southeastern and northeastern parts of the Uinta region, and the southeastern part of the Green River region. A core sample from one coal bed in Grand Mesa field, Uinta region, liberated more methane than did cores from any other region in the State. Although this particular bed emitted considerable gas (5.62 cc/g), the coal above and below this bed did not appear to be gassy (see Table 2).

An insufficient number of methane desorption tests have been conducted in Colorado to enable us to draw any direct conclusions regarding the occurrence and distribution of "gassy" coals in the State. However, the tests that we did run do suggest that the "deeper" coals (say, greater than 1000 ft. in depth) are not necessarily gassier than the "shallower" coals. Methane content of a coal appears to increase with rank. Therefore, a "deeper" bed of high-volatile C bituminous coal would be expected to contain less methane per unit volume than a high-volatile A bituminous coal from shallower depths.

We have yet to sample the same coal bed at various depths in order to determine whether the methane content of a given coal increases in a constant ratio with depth of occurrence, as has been observed in eastern U.S. coal fields.

To date, no coal cores have been obtained from the two known "gassiest" areas in the State (based on VM percentages, historic data, and recent MESA mine emission measurements; see Plate 1), which are the southern part of the Raton Mesa region (Las Animas County) and the southeastern part of the Uinta region (Coal Basin, in Pitkin County).

An interesting occurrence (which tends to corroborate the low volumes of gas measured in the coal desorbed to date) is the vacuum condition that develops when a desorption cannister is transferred from the coring sites (which ranged from 6440 to ± 7800 ft in elevation) to our office in Denver (elevation 5280 ft). With one exception--a sample from the southeastern part of the Green River region (elevation 6810 ft)--a vacuum developed in all of the desorption cannisters. The one exception referred to released only a small quantity of gas, which calculates to approximately 8 cu ft per ton of in-place coal. A check was made on one core, by cracking the cannister valve, to determine whether the methane being emitted would offset the vacuum in the cannister. Had any gas been emitted by the sealed coal sample, the pressure differential should have equalized. This particular cannister still retained a vacuum after desorption tests had been run for a 26-day period. Care must be taken under these circumstances not to allow water in the pan in which the graduated cylinder is placed to be sucked into the cannisters.

Grant-funded investigators from the Colorado Geological Survey collected coal samples for analyses and for methane desorption measurements from a working face in Mid-Continent Coal and Coke Company's Dutch Creek No. 2 mine in Pitkin County. Typical coal from this mine has the following as-received analysis (Collins, 1976, p. 84): 20.5% VM, 72.6% FC, 3.8% ash, 0.59% sulfur, 3.08% moisture, 14,697 Btu's/lb, and FSI-9. MESA methane emission measurements taken early in 1977 recorded nearly 1.5 million cu ft/day (1447.1 cu ft/ton of coal mined) from this mine. The 1,447 g sample from the fresh mine face emitted a total of 2,053 cc of methane during a period of over 3 months (most of this gas was desorbed during the first 4-6 weeks), which calculates 1.69 cc/g, or 54.23 cu ft/ton of in-place coal). Obviously, these figures would be much higher if both "lost" and residual gas were added to the desorbed amount (i.e., the total gas in virgin coal should be somewhat greater than what was actually emitted from the fresh working-face sample). Nevertheless, this mine sample has a higher apparent gas content than any of the core samples that we have desorbed so far.

Location of Study Area

Because the southeastern part of the Uinta region (Piceance Creek basin) was considered to be one of the two most desirable areas in Colorado for detailed investigation, it was necessary to review the geology of this region.

The area of interest includes parts of Delta, Garfield, Gunnison, Mesa, and Pitkin Counties, in west-central Colorado.

This region is bounded on the east by the White River uplift and by the Elk and West Elk Mountains; and on the south and southwest by the Gunnison and Uncompahgre uplifts. Structural relief on the Precambrian between the lowest point in the Piceance Creek basin and the highest point on both the White River and Uncompahgre uplifts is approximately 27,000 ft (Murray, Fender, and Jones, 1977).

The top of the Cozzette Sandstone, as shown on the structure map (Plate 4), ranges from 2,500 ft below sea level to more than 5,000 ft above sea level in the general area of interest. The Cozzette Sandstone was selected as a contour datum because (1) it is an easily identified and correlated marker on wire-line geophysical (well) logs on the region, and (2) it occurs a short distance below the main coal-bearing interval in the Mesaverde Group in this region (i.e, in the lower part of the Williams Fork Formation; refer to Plates 2, 3).

Stratigraphy and Sedimentation

The two stratigraphic cross sections (Plate 2, 3) prepared for this study show the formations of primary interest. The Mesaverde Group of Upper Cretaceous age is divided into the Iles and Williams Fork Formations. The Iles and Williams Fork terms basically are those used 100 miles to the north, in Moffat and Routt Counties. However, some workers carry these terms southward into the Carbondale-Coal basin area (Collins, 1972).

The Iles is the older of the two formations making up the Mesaverde Group. It consists of interfingering tongues of bluish gray to dark gray marine Mancos shales and siltstones, with very fine to sometimes coarse-grained, micaceous, lenticular sandstones. These sandstones, in ascending order (depending upon geographic location), are named the Sego, Corcoran, Cozzette, and Rollins (or Trout Creek, as it is termed farther north). The Rollins and Cozzette Sandstones are the two most useful beds for correlation purposes in the Mesaverde Group within the area of interest.

The Rollins Sandstone is the uppermost sandstone in the Iles Formation. It is silty at the base and grades upward into a coarse-grained, friable sandstone. The thickness of the Rollins, exclusive of the basal silt, usually is about 50 ft. In some areas, it may be much thicker, and the sand-silt ratio may change considerably.

Some thin coal beds occur in the Iles Formation in the studied area, associated with the Corcoran Sandstone and with several silty, sandy shale intervals. Collins (1976, p. 23-24) presents a good description of the complex stratigraphy of this lower Mesaverde (Iles Formation) sequence. Our examination of the historic mine records from this region reveals no evidence of production from these lower Mesaverde coal beds. Their rank and methane potential remain unknown.

It should be noted that the Cretaceous and Tertiary coal beds in Colorado are not so extensive or so uniform in thickness as are many of the Upper Paleozoic coals in the eastern part of the United States. Many workers in the western U.S. find that correlation of coal beds is difficult when the distance between control points exceeds one quarter of a mile.

The Williams Fork Formation, which overlies the Iles, is divided into three members in the Carbondale-Coal Basin area. The lower is named the Bowie Shale Member, the middle the Paonia Shale Member, and the upper the "Barren" Member. The Bowie and Paonia Members are coal-bearing. Some scattered, thin, and mostly non-minable coal seams exist above the Paonia Shale Member.

The Bowie Shale Member in the Coal Basin area, in Pitkin County, is 680 ft thick and consists of coal beds interbedded with fresh- to brackish-water sandstones, siltstones, and some thin shell zones. This member rests on the Rollins Sandstone (Collins, 1976). The top of the Bowie Member consists of a thick sandstone which is referred to as the "middle bed sandstone." The named coal beds in the Bowie Formation in the Carbondale-Coal Basin area are the Coal Basin, A, B, C, and D (Collins, 1976). This sequence includes the very gassy coking coal (medium-volatile bituminous) currently being mined at Coal Basin. The methane potential of these coals in the subsurface west of Coal Basin, in Pitkin, Mesa, and Gunnison Counties, is considered to be excellent.

The Paonia Shale Member is approximately 560 ft thick in the Coal Basin area. The Paonia consists of non-marine sandstones, siltstones, shales, and coal beds. The Paonia Member generally contains thinner coals than does the Bowie Member (Collins, 1976).

The Paonia Member rests on the "middle bed" sandstone; at the top of the member is a thick sandstone referred to as the "upper sandstone". The coal beds in the Somerset area, in ascending order, are the Somerset, Bear, Oliver, Hawk's Nest, and E. These coals typically are high-volatile C bituminous in the Somerset coal field area and are moderately gassy where mined from drift or slope mines near the outcrop areas. The methane potential of these coal beds in the subsurface away from the outcrops, where overburdens may range up to several thousand feet, is expected to be attractive.

The top member of the Williams Fork Formation consists of the "barren" member, or undifferentiated member, which contains very few coal beds. This unit extends from the top of the Paonia Member to the top of the Mesaverde

Group and is usually overlain by the Ohio Creek Conglomerate of Paleocene age.

The tops of the Bowie and Paonia Members generally can be picked by utilizing lithologic criteria obtainable through examination of drill cores or cuttings or in areas of outcrop; selecting these tops by means of electrical log character is difficult at best. The American Stratigraphic Company, a commercial sample logging firm headquartered in Denver, makes no attempt to mark the Bowie and Paonia tops on their sample logs of wells drilled in the study area.

Stratigraphic Cross Sections

Two cross sections (Plates 2 and 3) through representative oil and gas test wells drilled in the southeastern part of the Uinta region were constructed using film positives of the electrical surveys of those wells reduced to a vertical scale of 1" = 200' to facilitate correlation and graphic presentation. Well sample information was used to assist in identifying coal beds. This type of presentation is considered to be the most useful and accurate method for determining the lateral and vertical distribution, framework of deposition, and related aspects of coal beds, particularly from the regional standpoint.

The cross sections show formation names and tops, coal beds, isopach intervals, and the relationships of the coal zones to the Rollins and Cozzette Sandstones.

The north-south cross section (Plate 2) extends from T. 7 S., R. 91 W. to T. 12 S., R. 90 W. This section traverses Garfield, Mesa, and Gunnison Counties, and is located immediately west of the Coal Basin area in Pitkin County. The correlation datum is the top of the Cozzette Sandstone, which is present and identifiable on all of the electrical logs used on this section. The interval between the Cozzette and Rollins Sandstones thickens from 650 ft at the north end to 860 ft at the south end of the cross section.

The east-west cross section (Plate 3) commences in T. 11 S., R. 90 W., in Gunnison County on the east, and traverses Delta County to T. 9 S., R. 99 W., in Mesa County, on the west. The wells used on this cross section are much farther apart than are those used on the north-south cross section (Plate 2).

The top of the Rollins Sandstone was used as a correlation datum on this cross section. To the east, the Cozzette Sandstone is approximately 900 ft below the Rollins, whereas to the west, the interval between the two sandstones thins to less than 200 ft.

The most significant feature of the east-west cross section (Plate 3) is the difference in the character of the geophysical well logs on either end. East of T. 13 S., R. 93 W., the logs appear to be similar to those used on the north-south cross section, and coals are present in both the Bowie and Paonia Members. In contrast, the logs to the west of T. 13 S., R. 93 W. show that coal beds exist only in the Bowie Member (or in what may be more properly termed the "Cameo coal zone"). Also to the west, all units of the Mesaverde Group become thinner, and recognizing the top of the Bowie and Paonia Members becomes much more difficult.

Philip Eager, a geologist with the U.S. Geological Survey, Conservation Division, Denver, for the past year or so has been mapping the Mesaverde coal beds in the area between the towns of Cameo and Paonia, Colorado. Eager (oral communication) believes that the Bowie and Paonia Members cannot be recognized in the western part of the Grand Mesa area and that these terms should not be used here. He favors using the term "Cameo coal zone" when referring to the coal sequence lying above the Rollins Sandstone in the area west of T. 13 S., R. 93 W. He believes that there is evidence for a large sandstone buildup (offshore bar?) in the vicinity of T. 13 S., R. 93 W., Delta County. This sandstone appears to extend in a northerly direction and intersects the area traversed by our east-west cross section (Plate 3). Such sandstone buildups apparently influenced the deposition of coal in the Paonia Member, possibly by creating back-bar swamp conditions that could have favored the deposition of relatively thick layers of peat.

Eager recently completed a program of coal evaluation drilling in the Grand Mesa coal field, between Cameo and Paonia. Results of this study are expected to be open-filed by the U.S. Geological Survey, Conservation Division, by the end of May 1978.

Cozzette Sandstone Structure Map

A structure map, using the top of the Cozzette Sandstone as a contour horizon, was constructed on a scale of 1" = 3 miles (Plate 4). Because of the relatively small scale used, a contour interval of 500 ft was chosen, which allows only the major structural features to be shown, such as the northwest-trending axis of the Piceance Creek basin and the structural noses and/or closures of the larger gas fields. Gas wells and dry holes are shown by appropriate symbols, along with the tops of the Cozzette Sandstone, datum mean sea level, for each well studied. The outcrop of the Mesaverde-Mancos contact is shown on the map by a dashed line.

The structural control shown includes the top of the Dakota Formation where obtainable. However, the limited penetration to the Dakota by wells drilled in the area precluded constructing an accurate structure map on this horizon.

Any attempt to relate the Cozzette map to the coal beds can only be done on a general basis. Most of the known minable coal beds lie above the Cozzette Sandstone. Therefore, the map indicates the maximum depth at which one may expect to find most of the coal beds. The lateral extent of the coal beds is represented by the dashed Mesaverde-Mancos contact.

Coal Isopach Map

Plate 5 is a composite isopachous map of the total aggregate coal beds occurring in the Bowie Member (shown by solid lines) and in the Paonia Member (shown by dashed lines). A large-scale electrical log with formation tops marked is attached to one end of Plate 5 in order to present a more readable geophysical log of a typical well in the area studied.

The presence of coal beds was ascertained by carefully examining all of the geophysical logs available for each control well (electrical, together with gamma ray, sonic, density, etc., if run), plus any information obtainable regarding the microscopic examination of well cuttings. Thus, the reliability of our coal bed picks varies considerably from well to well (see Plates 2 and 3).

The isopach map (Plate 5) shows that the greatest aggregate thickness of Mesaverde coals extends in a north-south direction near the eastern edge of the Piceance Creek basin. This map also reveals the absence of coal above the "Cameo zone" (Bowie equivalent?) in the western half of the mapped area. There is some subsurface evidence that relatively thick coal beds exist at depths below the total depths of the control wells used to construct the isopach map.

COAL MINES EXAMINED

A total of five underground coal mines in west-central Colorado were examined by members of the Colorado Geological Survey and the U.S. Bureau of Mines. These visits were for the purposes of (1) obtaining working-face channel samples for USGS/USBM chemical analysis, (2) measuring cleat directions, (3) studying various geological and engineering problems associated with mining, (4) observing techniques used to mine Western steam and metallurgical coals, and (5) studying the stratigraphy of the coal-bearing sequences in outcrops near the mine portals. Table 3 is a summary of the data obtained during these mine visits, together with representative coal analysis information for the mines studied (U.S. Bureau of Mines, 1976).

The following mines were visited and examined during the term of this two-year grant:

GUNNISON COUNTY (Uinta coal region)

BEAR MINE (Bear Coal Co.) (Sec. 9, T 13 S, R 90 W)
Coking coal; 1977 production, 226,220 short tons
(on strike in December)

HAWK'S NEST WEST (#2) MINE (Western Slope Carbon, Inc.)
(Sec. 12, T 13 S, R 90 W)
Coking coal; 1977 production, 12,362 tons
(on strike in December)

SOMERSET MINE (U.S. Steel Corp.) (Sec. 8, T 13 S, R 90 W)
Coking coal; 1977 production 914,552 tons
(on strike in December)

MESA COUNTY (Uinta coal region)

C. M. C. MINE (Cambridge Mining Corp.)
(Sec. 34, T 10 S, R 98 W)
Steam coal; 1977 production, 300,199 tons

PITKIN COUNTY (Uinta coal region)

DUTCH CREEK NO. 1 MINE (Mid-Continent & Coke Co.)
(Sec. 17, T 10 S, R 89 W)
Coking coal; 1977 production 232,481 tons.
The first advancing longwall mining machine ever installed in a U.S. coal mine is being used in this mine under an overburden cover of some 2,800 feet.

COLORADO COAL DIRECTORY

While we were compiling data on active and proposed coal mines and coal exploration programs in Colorado, we learned that David H. Hebb and M. S. Curtin, of the Mineral Economics Research Institute, Colorado School of Mines, had obtained a grant funded by the U.S. Bureau of Mines, Denver, to conduct a study of coal shipments, contracts, etc. in the State. This report, entitled, "Production and shipments of coal in Colorado", was submitted in February 1977 to the Intermountain Field Operation Center, U.S. Bureau of Mines, in Denver.

We have combined the results of our survey of coal companies in Colorado with the results of the Hebb and Curtin unpublished report, and have expanded the overall scope of the compilation to include other pertinent and related information. The results of this survey of the coal industry in Colorado, probably the most comprehensive yet made, will be published in the spring of 1978 by the Colorado Geological Survey. Special computer programs have been custom-designed to accommodate the great variety of information contained in this Directory, which includes individual data sheets on both licensed and proposed coal mines, a directory of companies and consultants located in Colorado that are known to be active in the coal industry in the State, and considerable statistical information. This directory is designed for input into our in-house computerized word-processing system so that it can be revised, corrected, and updated as the need arises (Murray and Dawson, 1978).

This dynamic system will permit virtually instantaneous printouts of mine and company/consultant data in a number of formats. For example, one format will print out all of the proposed mines in a given county; another format will list all of the operating coal companies with offices in Colorado.

The following is a tentative table of contents for this new Colorado Coal Directory:

INTRODUCTION
SCOPE OF COAL DEVELOPMENT
    National, Regional, Local

COUNTY COAL STATISTICS
COAL MINE MAP, INDEX, AND LOCATION DATA
COAL SHIPMENT STATISTICS
COAL DEALER DIRECTORY
COAL MINE PRODUCTION AND MARKETING TABLES
COAL MINE PRODUCTIVITY AND EMPLOYMENT TABLES
USE OF COAL/COST OF COAL
COAL-FIRED POWER PLANT DIRECTORY
MAP OF COLORADO TRANSPORT ROUTES
TRANSPORTATION DIRECTORY
DIRECTORY OF COAL MINE-RELATED DEVELOPMENTS
    Coking Plants, Conversion Plants, Cleaning Plants, Crushing Plants, Impacted Communities, and Local Contracts

PERMIT AND REGULATIONS DIRECTORY
DIRECTORY OF OTHER AGENCIES ACTIVE IN COAL DEVELOPMENT
DIRECTORY OF COMPANIES AND CONSULTANTS ACTIVE IN COAL DEVELOPMENT

Operating Companies
Coal Equipment Dealers
Service Companies
Supply Companies
Consulting Firms and Consultants
Financial Institutions

SURVEY OF COAL-FIRED HEATING EQUIPMENT MANUFACTURERS (COLORADO)

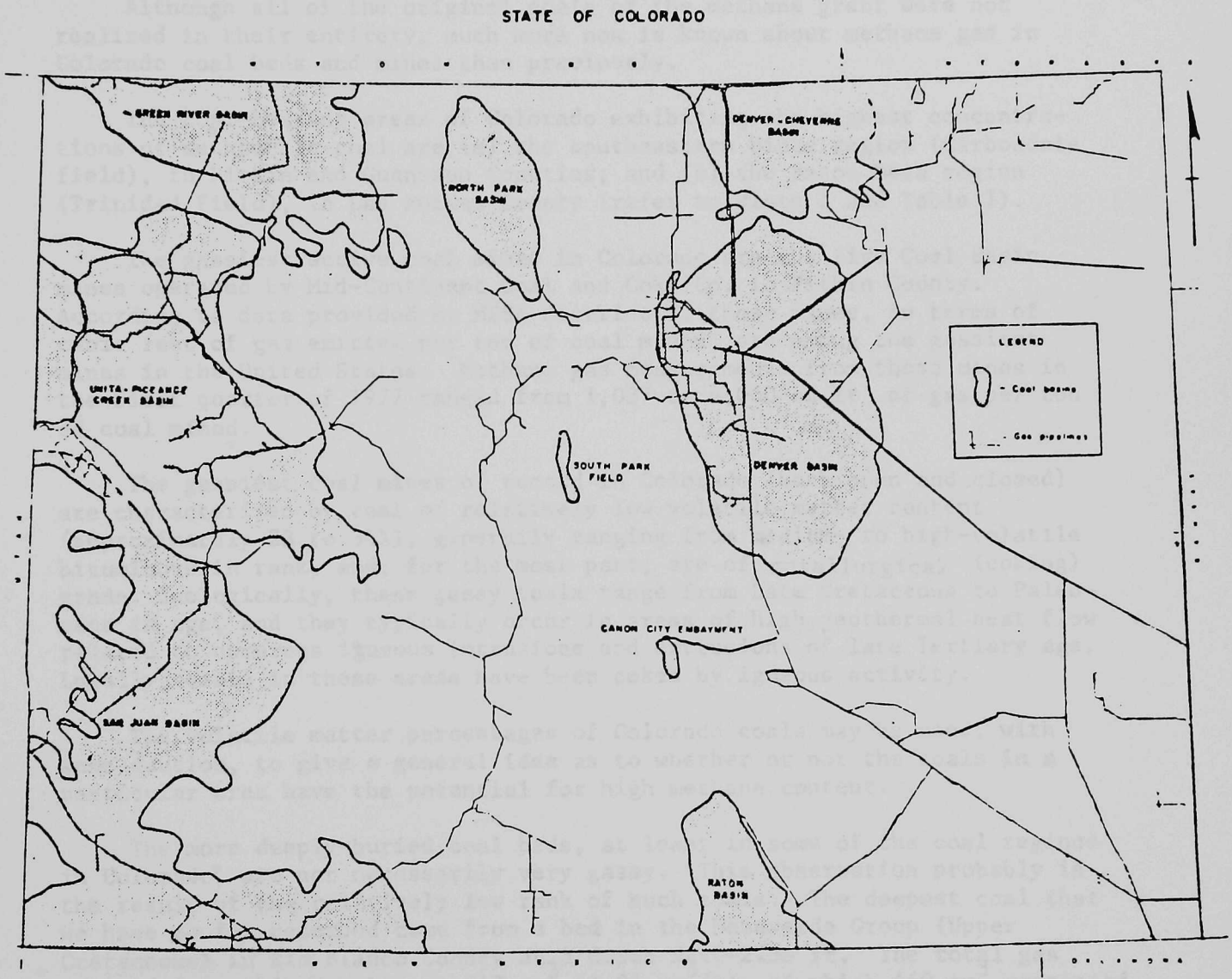

Fig. 1. Map showing major natural gas pipelines in Colorado (after McCulloch and Deul, 1977).

GAS PIPELINE MAP OF COLORADO

A map entitled "Gas Pipeline Map of Colorado" (Jones, 1975), scale 1:500,000 (Figure 1), was constructed showing the route of all major and many secondary gas pipelines, together with their diameters and ownership; and the location and capacity of each gas processing plant and underground gas storage facility. This information is included on the Energy Resources Map of Colorado (U.S.G.S. and C.G.S., 1977).

CONCLUSIONS

Although all of the original goals of the methane grant were not realized in their entirety, much more now is known about methane gas in Colorado coal beds and mines than previously.

The coal-bearing areas of Colorado exhibiting the highest concentrations of methane in coal are (a) the southeastern Uinta region (Carbondale field), in Pitkin and Gunnison Counties; and (b) the Raton Mesa region (Trinidad field), in Las Animas County (refer to Plate 1 and Table 1).

The gassiest active coal mines in Colorado are the five Coal Basin mines operated by Mid-Continent Coal and Coke Co. in Pitkin County. According to data provided by MESA District 9, these mines, in terms of cubic feet of gas emitted per ton of coal mined, are among the gassiest mines in the United States. Methane gas measurements from these mines in the first quarter of 1977 ranged from 1,037 to 4,060 cu ft of gas per ton of coal mined.

The gassiest coal mines of record in Colorado (both open and closed) are characterized by coal of relatively low volatile matter content (approximately 23 to 36%), generally ranging from medium- to high-volatile bituminous in rank, and, for the most part, are of metallurgical (coking) grade. Geologically, these gassy coals range from Late Cretaceous to Paleocene in age, and they typically occur in areas of high geothermal heat flow related to numerous igneous intrusions and extrusions of late Tertiary age. Locally, coals in these areas have been coked by igneous activity.

The volatile matter percentages of Colorado coals may be used, with some caution, to give a general idea as to whether or not the coals in a particular area have the potential for high methane content.

The more deeply buried coal beds, at least in some of the coal regions in Colorado, are not necessarily very gassy. This observation probably is the result of the relatively low rank of such coals. The deepest coal that we have so far desorbed came from a bed in the Mesaverde Group (Upper Cretaceous) in Rio Blanco County at a depth 2240-2250 ft. The total gas emitted from this sample was 613 cm^3 (1.31 cm^3/g), of which 460 cm^3 consisted of a questionable back-calculation of gas lost during coring and retrieval operations. Analytical results for this core are not presently available due to the company's request for confidentiality. The gassiest coal core came from the Mesaverde Group in Delta County from a depth of 707 ft. The total gas emitted from this sample was 1338 cm^3 (5.62 cm^3/g). However, coal cores collected from both above and below this seam emitted almost no gas (Table 2).

Whenever the pressure of the gas emitting from a coal sample sealed in a desorption cannister is unable to overcome the pressure differential caused by a change in elevation from the well site to Denver, it might be concluded that the methane content of this particular coal is low. However, such a conclusion may be erroneous. Some blocky coals in Appalachian fields, for example, reportedly emit only about 50 percent of their contained gas, even after several months of desorption in a sealed cannister. Obviously, these coals must have a high residual gas content.

As additional coal cores are made available to the Colorado Geological Survey for methane desorption, and as more residual gas measurements are made using the Bureau of Mines' new sealed ball mill technique, we hope that satisfactory answers to these and other vexing problems may be found.

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FORM 1

STATE OF COLORADO

RICHARD D. LAMM
GOVERNOR

JOHN W. ROLD
Director

COLORADO GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES
715 STATE CENTENNIAL BUILDING – 1313 SHERMAN STREET
DENVER, COLORADO 80203 PHONE (303) 892–2611

The Colorado Geological Survey is currently conducting studies on several coal projects which should be of interest to all companies involved with exploring for and mining Colorado coal.

This letter contains a brief description of each project so that you may be cognizant of this work. It may be that your company will never be involved in all phases of these projects.

I should emphasize that designated confidential information will be kept as such by all concerned parties until your permission for release has been given. Also, any coal samples, cores, or other related data that your company provides which are used for analyses, desorption, or other tests will entitle your company to copies of the results at no charge.

The projects consist of the following three Federal grants and one State-generated tabulation:

Colorado Coal Directory Data - (State)

Enclosed you will find a partially filled out self-explanatory form for active and/or proposed coal mines, whichever is applicable to your company. We will appreciate any additions or corrections you may wish to make. We will honor the confidentiality of any items so marked. The "consumer contracts" data may require a separate sheet. For companies operating more than one mine, additional forms are enclosed— one for each mine.

Methane Grant - (Federal)

The stated goal of this grant project is to locate an area in Colorado containing gassy coal beds which may be penetrated by a vertically drilled hole in which one or more coal beds may be hydraulically stimulated by the hydro-fracture method currently being employed by the petroleum industry to enhance the production of oil and gas.

This procedure could result in developing new reserves of pipeline-quality gas, improving mine safety, and increasing mine productivity. Fracture treatments in other areas of the country have increased the flow of methane from coal beds by several fold.

If successful, this project could be invaluable to coal companies. To a large degree, the success of this project depends upon the willingness of coal companies to provide information such as sample logs, core logs, mine maps, tonnage figures, and portions of freshly-cut cores. Core splits from freshly-cut cores are needed to calculate the cubic feet of gas contained in a ton of coal. The procedure is to seal the coal splits in a cylinder at the drill site. Gas is released from the cylinder each day and measured. This data applied to a formula will show the cubic feet of gas in place per ton of coal. The desorbing process takes about three weeks.

Upon completion of the test, and if the company so desires, the U.S.G.S. will run trace element analyses, and the U.S.B.M. will perform the usual proximate and ultimate analyses, etc. on the degasified core.

Coal Sampling Grant - (Federal)

The purpose of this grant is to collect coal samples from each active coal mine in Colorado, and from cores of coals likely to be mined in the future. The U.S.G.S. will run trace element analyses, and the U.S.B.M. will run the conventional proximate, ultimate, etc. analyses.

Coking Coal Grant - (Federal)

The purpose of this grant is to determine which coals in Colorado are favorable for coking. Data needed include thickness of beds, depth to beds, areal extent of beds, estimated reserves, and other factors. This project requires that coal samples be taken from cores or from underground mines.

Calculation of Remaining Coal Reserve Base in Colorado by Coal Bed and County - (Federal)

The purpose of this grant is to compile data on mined or potentially mineable coal by bed and by county; to determine the amount of coal mined to date, and to determine the remaining coal reserves in each county, by coal bed or zone. Detailed information desired would include the name of the coal bed, thickness, depth, and areal extent of the bed.

The Colorado Geological Survey will be most grateful for whatever support the coal industry of Colorado can provide in order that these projects may be successfully completed.

Sincerely,

D. Keith Murray
Mineral Fuels Section

HBF/DKM/jp

STATE OF COLORADO

RICHARD D. LAMM
GOVERNOR

JOHN W. ROLD
Director

COLORADO GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES
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DENVER, COLORADO 80203 PHONE (303) 892–2611

DATA ACCUMULATION ON THE METHANE POTENTIAL OF THE COAL BEDS OF COLORADO

U.S. Bureau of Mines Grant No. G-0166008, awarded to the Colorado Geological Survey (Grant term October 1, 1975-September 30, 1977)

DESCRIPTION OF PROJECT

Goal:

The goal of this grant project is to locate an area in Colorado containing gassy coal beds that may be penetrated by a hole drilled vertically to a reasonable depth in which one or more coal beds may be stimulated by the hydraulic fracturing method currently being employed by the petroleum industry. This treatment usually enhances production.

Results:

Successful completion of the methane project could result in the development of new reserves of pipeline-quality gas, improvement of mine safety, and increases in mine productivity.

Data desired for the project:

1. Drill hole sample logs
2. Core logs
3. Geophysical well logs
4. Cleat direction
5. Two or more 5' coal seams
6. Seam depths from 900'-1500'
7. Coal seams to extend over extensive area
8. Portions of freshly cut cores for methane desorption
9. Mine maps
10. Coal reserve data
11. Tonnage produced
12. Any gas problems
13. Near a town
14. Near a gas pipeline

Desorption procedure:

Splits from freshly cut cores are needed to calculate the cubic feet of gas contained in a ton of coal. The procedure is to seal in a cylinder the coal splits as soon as possible after retrieval from the core barrel at the drill site. Gas released from the cylinder is measured at regular intervals. The cubic feet of gas in-place per ton of coal can thus be calculated from the resulting data. The amount of core required for desorption is 1000+ grams. The desorption process takes about 3 weeks.

Analysis:

Upon completion of the desorption process, and if the operator so desires, the U.S. Geological Survey will run trace element analyses on one portion of the degasified core, and the Bureau of Mines will perform conventional (proximate, ultimate, etc.) analyses on a second split. Approximately 4 to 5 months generally are required before the final analyses have been completed and sent to the Colorado Geological Survey. If a company prefers to have the analyses run by their own commercial contractor, the desorbed portion of the core can be returned to the company with no alteration other than the desorption of most of the contained methane. The desorption and/or analytical data from any core sample provided to the Colorado Geological Survey will be available at no cost to the company involved.

Confidentiality

All resulting data will be kept confidential until the operator grants permission for its release.

Notice for Collecting Cores

It is preferred that we be notified at least one day prior to the day of the coring operation in order that CGS personnel can be at the drill site prior to penetration of the coal bed.

Should your company wish to cooperate in this methane-in-coal project, please contact either of the following:

D. Keith Murray, Principal Grant Investigator
(office, 892-2611; home, 233-6422)
H. B. Fender, Assistant Grant Investigator
(office, 892-2611; home, 421-8153)

H. B. Fender

H. B. Fender
Assistant Grant Investigator

HBF/ef

PRODUCING/LICENSED COAL MINE DATA SHEET

COUNTY:

COAL REGION:

FIELD NAME:

MINE NAME:

LOCATION (Active surface operation or underground entry): *mi.* *of*
*Sec.*_____ *Twp.*_____ *Rge.*_____

TYPE OF MINE:

MINING METHOD:

STARTUP DATE:

DEPTH OR OVERBURDEN:

NAME OF COAL BED(S):

GEOLOGIC FORMATION/ROCK UNIT:

GEOLOGIC AGE:

THICKNESS OF COAL BED(S), FEET:

DIP, DEGREES:

RANK OF COAL:

USE OF COAL:

PROXIMATE ANALYSIS (AS-RECEIVED):

Heat value, Btu/lb.:
Sulfur, %:
Moisture, %:
Ash, %:

MINE OPERATOR(S):

(name)
(address)

(telephone no.)

CORPORATE AFFILIATION:

COMPANY OFFICIALS:

LEASE INFORMATION:

PRODUCTION DATA (SHORT TONS):
Cumulative to 1/1/77:
1975
1976
1977 (est.)
197_ (projected)
19___(projected)

NUMBER OF EMPLOYEES:
1975
1976
1977(est.)
197__ (projected)
19___ (projected)

ESTIMATED LIFE/RESERVES:

SALES DATA:

PROPOSED COAL MINE DATA SHEET

COUNTY:

COAL REGION:

FIELD NAME:

MINE NAME:

LOCATION (Active surface operation or underground entry): *mi.* *of* *Sec.*_____ *Twp.*_____ *Rge.*_____

TYPE OF MINE:

MINING METHOD:

STARTUP DATE:

DEPTH OR OVERBURDEN:

NAME OF COAL BED(S):

GEOLOGIC FORMATION/ROCK UNIT:

GEOLOGIC AGE:

THICKNESS OF COAL BED(S), FEET:

DIP, DEGREES:

RANK OF COAL:

USE OF COAL:

PROXIMATE ANALYSIS (AS-RECEIVED):

Heat value, Btu/lb.:
Sulfur, %:
Moisture, %:
Ash, %:

MINE OPERATOR(S):

(name)

(address)

(telephone no.)

CORPORATE AFFILIATION:

COMPANY OFFICIALS:

LEASE INFORMATION:

PRODUCTION DATA (SHORT TONS):

19__ (projected)

19___ (projected)

NUMBER OF EMPLOYEES:

19__ (projected)
19___ (projected)

ESTIMATED LIFE/RESERVES:

SALES DATA:

STATUS OF MINE:

FORM 5

CORE SAMPLE DATA SHEET

Company Drill Hole No. (Sample No.)_____ Date_____
(tape Company Name and Drill Hole No. on cylinder)
Company_____ Person Collecting Core_____

Drilling Company_____

Hole Location_____

County_____ State_____

Core Size_____ Barrel Length_____ Type of Core Retrieval_____

Drilling Media_____ Air Temperature_____ Surface Elevation_____

Coalbed_____ Coal Thickness_____

Depth to base of coalbed_____ Total Depth of Hole_____

Roof Rock_____

Floor Rock_____

Character and type of coal_____

Seam Description_____

Condition of Sample_____

Sampled Interval_____ Cored Interval_____

Cylinder Wt._____gm. Cylinder Wt. + Coal_____gm. Coal Sample Wt._____gm.

Time Coring Started_____ Time Coring Completed_____

Time Coalbed Encountered (A)_____ Time Core Started Out of Hole(B)_____

Time Core Reached Surface (C)_____ Time Core Sealed in Cannister (D)_____

RESULTS

Lost Gas Time: (D-A) if air or mist is used_____

$(D-C) + (\frac{C-B}{2})$ if water is used_____

$\sqrt{\text{Lost Gas Time}}$ in minutes_____ Lost gas (cm^3)_____

Gas from Canister (cm^3)_____

Residual Gas from Crushing (cm^3/g)_____

GAS CONTENT CALCULATION ($\frac{cm^3}{g}$)

$$\text{Gas Content} = \frac{\text{Lost Gas } (cm^3) + \text{Gas from Canister } (cm^3)}{\text{Sample Weight (gm)}} + \text{Residual Gas from Crushing } \frac{(cm^3)}{gm}$$

Total $cm^3/g \times 32 = Ft^3/Ton$

FORM 6

State:	County:	Location:	Hole No.:	P.

Time 0 = Date	Time	Elapsed Min.	$\frac{\emptyset}{\sqrt{T^*}}$	Cylinder Reading 1 ml 2	Cm^3 Gas Released	Cm^3 Total Gas $\emptyset$	DER Cm^3/g ↓	Cylinder No.: Sample Wt.: Comments

* "Lost" gas time + desorption time in minutes

↓ Sample Weight $\sqrt{\text{Daily Emission}}$ = DER

R = Reverse Flow

$\emptyset$ Plot on Figure 4 graph

$\sqrt{\text{"Lost" Gas Time}}$ =

FORM 7

State:_____ County:_____ Loc.:_____

Co.:_____ Hole No.:_____ Cyl. No.:_____

Date Started:_____ Date Completed:_____

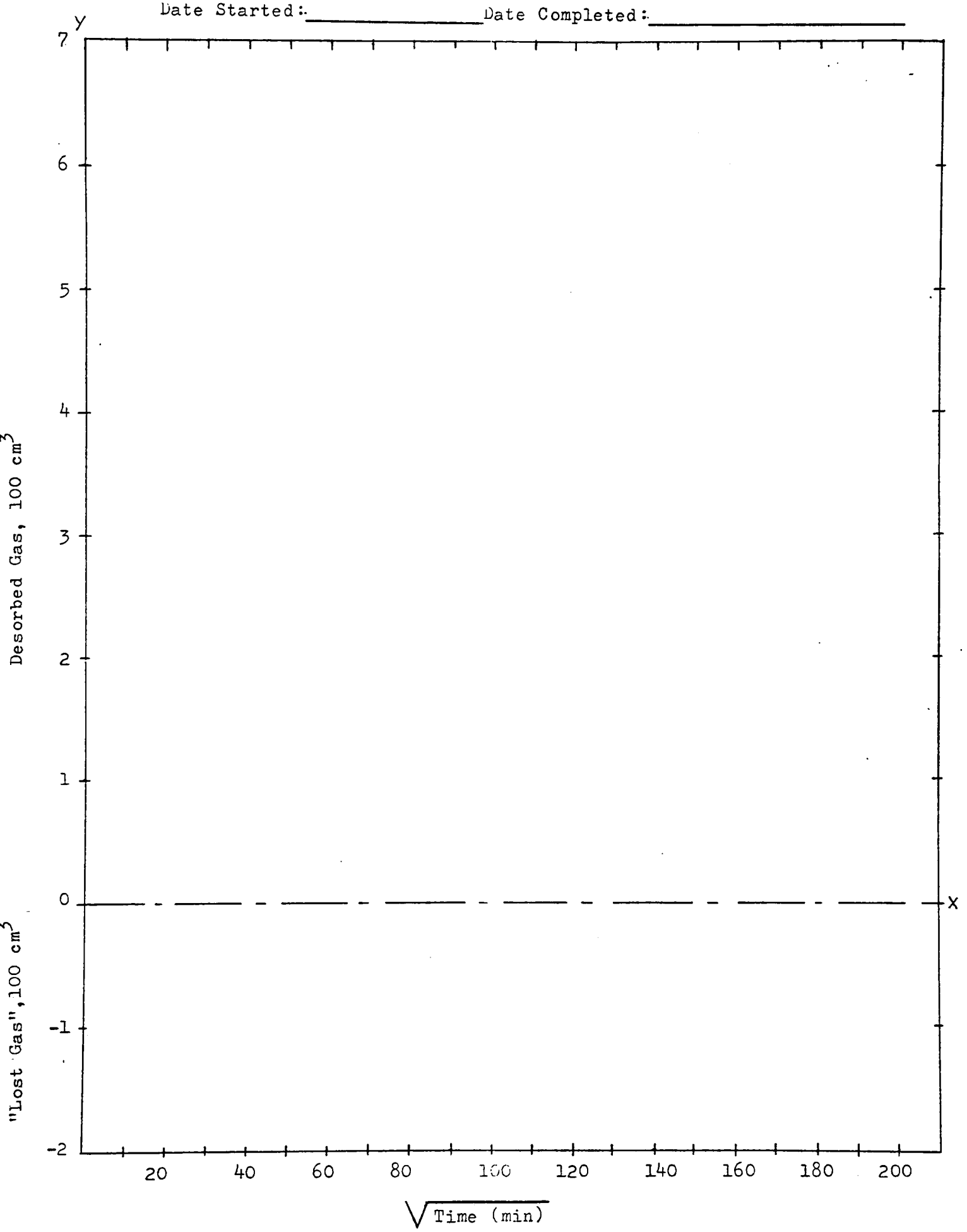


TABLE 1: OCCURRENCE OF METHANE GAS

MAP NO.	COUNTY COAL REGION (FIELD) MINE NAME (A)= active mine	MINE LOCATION (Sec.,Twp.,Rge.) (Location of entry underlined)	NAME OF MINED BED	COAL BED THICKNESS (FT)	OVERBURDEN THICKNESS (FT) (U)= Unknown	SHAFT DEPTH (FT)	COAL RANK (1)
	BOULDER						
	Denver (Boulder-Weld)						
1	Hi-Way	13,14,23,26,1S-69W	Boulder	6-7	300	385	SB-
2	Monarch #2	20,21,28,29,32,33,1S-69W	Uncorrelated	7(upper)	285-375	375	SB
3	Nonpareil	16,17,1S-69W		4(lower)	285	285	SB
4	Simpson	34,35,1N-69W 2,3,1S-69W	Simpson	6-14	225-240	240	SB
5	Standard	1,12,1S-69W	L. Lafayette	5.5-8		320	SB
6	Sunnyside	28-1S-69W		5		324	SB
	DELTA						
	Uinta (Somerset)						
1	Blue Ribbon	2, 13S-91W		6	(U)		B-hv
	Uinta (Grand Mesa)						
2	Independent	13, 13S-95W	#2	6.2	100		B-hv
	Uinta (Somerset)						
3	King (A)	9,10,11,14,15,13S-91W	Uncorrelated	16	2000		B-hv
	Uinta (Grand Mesa)						
4	Tomahawk	10,15,16,13S-95W	Green Valley	11	(U)		B-hv
	EL PASO						
	Denver (Colorado Springs)						
1	City #2	29,33,13S-66W		14		43	SB
2	Pikeview	12,13,13S-67W 7,18,13S-66W	Fox Hill	7-14		173	SB
	FREMONT						
	Canon City (Canon City)						
1	Beacon	27,19S-70W		3.5	(U)		B
2	Blue Flame Gas	12,19S-70W	Griffiths	2.2	(U)		B
3	Brookside	10,11,14,15,19S-70W	Brookside	3	(U)		B-hv
4	Canon Liberty #3	19,30,20S-69W		3.3	(U)		B-hv
5	Coal Creek #1 & 2	6,19,30,31,19S-69W,1,31,36,20S-70W	Canon	3.6-5		400	B
6	Golden Quality #1	10,20S-70W		8	(U)		B

IN COLORADO COAL MINES

DAILY PRODUCTION SHORT TONS (1st qtr., 1977)	AVERAGE METHANE EMISSION CU.FT./DAY (1st qtr., 1977)	CU.FT.GAS/TON OF COAL MINED	COAL ANALYSIS-DRY(MOIST & BTU-AS REC'D) MOISTURE (AVE.) (As-rec'd)	SULFER (AVE.) (Dry)	ASH (AVE.) (Dry)	VOLATILE MATTER (AVE.)	FIXED CARBON (AVE.) (Dry)	BTU/LB (AVE.) (As rec'd)	OCCURRENCE OF GAS IN MINES(2) (YEAR)	
Closed			20.7	.3	5.6	38.7	55.5	9933	GE(1939) MF ?	1
Closed			19.8	.5	5.2	38.8	55.9	10155	GE(1936)	2
Closed									GE(1908)	3
Closed									GE(1912)	4
Closed									GE(1908)	5
Closed									GE(1902)	6
Closed			6.4	.5	4.1	40.8	55.0	12927	G	1
Closed									MF(1930)	2
			3.9	.4	4.6	41.9	53.5	13400	G	3
			4.3	.5	5.7	41.0	53.1	13198	MF(1911)	
Closed			13.8	.8	9.3	38.4	52.3	10795	G	4
Closed									GS ?	1
Closed			23.1	.5	8.0	42.5	48.1	8730	GE(1956)	2
Closed									MF(1910)	1
Closed									GE(1941)	2
Closed			9.4	.6	9.7	38.6	51.6	11212	MF(1910) MF(1961)	3
Closed			9.7	1.1	8.7	40.4	50.8	11293	G	4
Closed									GE(1885 1886,1888)	5
Closed									G	6

TABLE 1: OCCURRENCE OF METHANE GAS

MAP NO.	COUNTY COAL REGION (FIELD) MINE NAME (A) = active mine	MINE LOCATION (Sec.,Twp.,Rge.) (Location of entry underlined)	NAME OF MINED BED	COAL BED THICKNESS (FT)	OVERBURDEN THICKNESS (FT) (U) = Unknown	SHAFT DEPTH (FT)	COAL RANK (1)
7	Golden Quality #2	12,19S-70W		3.5	(U)		B
8	Golden Quality #3	12,13,19S-70W	Magnet	3.5	(U)		B-hv
9	Golden Quality #5(A)	2,20S-70W	Brookside	8	(U)		B
10	Griffiths	12,13,19S-70W	Ocean Wave or Magnet	3.5	(U)		B
11	Rockvale	25,36,19S-70W 19,30,31,19S-69W	Canon City	5.3-7.3	300-350 423		B
12	Rockvale #3	4,5,8,9,19S-70W	Nonac(?)Rockvale(?)	3.5-6			B-hv
	GARFIELD						
	Uinta(Grand Hogback)						
1	Black Raven	16,5S-92W		22	0-257		B-hv
2	Coryell	2,6S-91W,31,32,55S-90W	Allen	14.5	0-125		B-hv
	Uinta (Carbondale)						
3	Four Mile (A)	34,7S-89W	"A","C","D"	9.5	0-1100		B-hv
	Uinta (Grand Hogback)						
4	Harvey Gap (Old)	24,5S-92W		6	(U)		B-hv
5	Harvey Gap #2	19,5S-91W,24,5S-92W	"F"	5-11	(U)		B-hv
6	Harvey Gap #3	24,5S-92W		6	17-211		B-hv
7	IHI #3	16,5S-92W		9	281-667		B
8	McLearn	12,5S-93W,7,5S-92W		6-7	(U)		B
9	New Castle	30,31,32,5S-90W, 36-5S-91W,1-6S,91W	Wheeler	8-42	(U)		B-hv
10	New Castle-Vulcan	1,6S-91W	Allen	8-14	350-400		B-hv
11	South Canon #1	14,6S-90W	"D" Wheeler "E" Allen	18 (Ave.)	500-550		B-hv B-hv
	Uinta (Book Cliff)						
12	Stove Canon	11,12,8S-102W	Palisade	3.2-7	300-700		B-hv
	Uinta (Grand Hogback)						
13	Sunny Ridge	24,5S-92W		7	140		B-hv
14	Vulcan	1,6S-91W	Allen	14-47	350-400		B

IN COLORADO COAL MINES

DAILY PRODUCTION SHORT TONS (1st qtr., 1977)	AVERAGE METHANE EMISSION CU. FT./DAY (1st qtr., 1977)	CU.FT.GAS/TON OF COAL MINED	COAL ANALYSIS-DRY(MOIST & BTU-AS RECV'D MOISTURE (AVE.) (As-Rec'd.)	SULFUR (AVE.) (Dry)	ASH (AVE.) (Dry)	VOLATILE MATTER (AVE.)	FIXED CARBON (AVE.) (Dry)	BTU/LB (AVE.) (As rec'd)	OCCURRENCE OF GAS IN MINES(2) (YEAR)	MAP NO.
Closed									G	7
Closed			8.4	1.4	9.8	42.2	47.9	11523	G	8
									G	9
Closed									GE(1937)	10
Closed									GE(1888)	11
Closed			8.8	.7	8.0	41.3	52.0	11623	G	12
Closed			7.2	.4	4.2	44.6	51.1	12295	MF(1963)	1
Closed			14.6	.3	5.7	37.9	56.3	11179	GE(1901)	2
40	None	0	5.8	.9	4.7	41.9	58.3	12684	GE(1897)	3
Closed			4.3	2.2	9.8	39.7	50.5	12401	GE(1926)	4
Closed			4.5	1.9	7.5	40.8	51.7	13086	G	5
Closed			4.1	.7	8.7	39.5	51.7	12671	G	6
Closed									GE(1954)	7
Closed									G	8
Closed			4.4	.6	8.2	41.4	50.4	12477	GE(1901)MF(1954) DE(1888)	9
Closed			4.3	.6	5.4	40.6	54.0	13229	MF(1962)	10
Closed			6.8 6.5	.4 .5	10.4 3.1	41.0 42.7	48.5 54.1	11725 12710	GE(1912) MF(1951)	11
Closed			9.3	.7	8.2	38.9	52.0	11872	G	12
Closed			5.0	.4	8.8	41.5	49.6	12258	DE(1951)DE(1952)	13
Closed									DE(1913)GE(1896) GG(1978)GE(1956)	14

TABLE 1: OCCURRENCE OF METHANE GAS

MAP NO.	COUNTY COAL REGION (FIELD) MINE NAME (A) = active mine	MINE LOCATION (Sec.,Twp.,Rge.) (Location of entry underlined)	NAME OF MINED BED	COAL BED THICKNESS (FT)	OVERBURDEN THICKNESS (FT) (U) = Unknown	SHAFT DEPTH (FT)	COAL RANK (1)
15	Vulcan #3	1,6S-91W			(U)		
	GUNNISON						
	Uinta (Somerset)						
1	Bear (A)	9,16,13S-90W	Juanita "C"	8	290-1440		B-hv
2	Black Beauty	1,2,10,11,12,13S-90W	"E"	10	897		B-hv
	Uinta (Crested Butte)						
3	Crested Butte	3,10,11,15,14S-86W	Crested Butte	5-25	300-400		B-hv
	Uinta (Somerset)						
4	Edwards	8,17,13S-90W	"B"	6	511-634		B-hv
			"C"	6	511-634		B-hv
	Uinta (Carbondale)						
5	Genter	20,11S-88W		3.2-4.9	148-705		A
	Uinta (Somerset)						
6	Oliver #2	10,15,13S-90W	Oliver	7	(U)		B-hv
7	Oliver #3	10,13S-90W	"E"	7	174-500		B-hv
8	Somerset (A)	8,9,13S-90W,2,10,12S-90W	Var.		-		B-hv
			B	25	1000-1500		B-hv
			C	7	-		B-hv
	HUERFANO						
	Raton (Walsenburg)						
1	Alamo	35,36,27S-68W	Walsen or Cameron	9	600-1800		B
2	Alamo #2	25,36,27S-68W	Vermijillo	10	(U)		B-hv
3	Calumet #2(see Delcarbon)	14,15,22,23,27S-67W	Walsen Robinson Cameron Lenox	4-5	250		B
4	Cameron	16,17,18,19,20,21,28S-66W	Walsen & Cameron	7	165-500	170	B
5	Gordon	22,23,26,27,27S-67W	Various		(U)		B-hv
			Cameron	4			B-hv
6	Hezron	7,12,13,14,18,29S-66W	Robinson	4			B
7	Maitland	36,27S-67W 1,6,31,27S-66W	L. Robinson	3.5	165-200		B-hv
8	Midway	19,29S-65W		4.5-5.6	(U)		B
9	Mutual	18,28S-66W	Walsen	7.1	400		B

IN COLORADO COAL MINES

DAILY PRODUCTION SHORT TONS (1st qtr., 1977)	AVERAGE METHANE EMISSION CU.FT./DAY (1st quarter, 1977)	CU.FT.GAS/TON OF COAL MINED	COAL ANALYSIS-DRY(MOIST & BTU-AS RECV'D) MOISTURE (AVE.) (As-Rec'd.)	SULFUR (AVE.) (Dry)	ASH (AVE.) (Dry)	VOLATILE MATTER (AVE.)	FIXED CARBON (AVE.) (Dry)	BTU/LB (AVE.) (As rec'd)	OCCURRENCE OF GAS IN MINES (2) (YEAR)	MAP NO.
Closed									GE(1918)GE(1956)	15
600	259,000	431.6	5.7	.5	6.0	40.8	53.1	12812	G	1
Closed			6.2	.6	4.2	40.7	54.9	12940	G	2
Closed			3.5	.4	5.4	38.9	55.6	13308	GE or DE(1883), GE(1884)	3
Closed			5.0	.4	8.4	40.2	51.2	12570	G	4
			6.1	.4	6.1	40.4	51.4	12732	G	
Closed									GE(1925)	5
Closed			6.1	.5	6.8	40.5	52.6	12573	G	6
Closed			6.5	.5	4.4	41.1	54.3	12896	G	7
4500	1,692,000	376	6.4	.7	6.1	39.5	54.4	12755	G	8
			5.4	.5	11.5	38.8	51.0	12412	G	
			5.6	.6	7.4	39.4	53.6	12737	G	
Closed									GE(1924)	1
Closed			7.1	.9	11.5	38.7	49.6	11393	GE(1942,1943)	2
Closed			6.2	.8	10.2	39.5	49.7	11743	G	3
Closed									GE(1918)	4
Closed			5.9	.6	12.1	39.7	46.9	11373	G and	5
			6.1	.8	11.4	39.9	48.9	11765	GE(1925)	
Closed									GE(1918)	6
Closed			6.2	.6	14.0	37.6	48.3	11245	GE(1906)	7
Closed									GE(1907)	8
Closed									GE(1915)	9

TABLE 1: OCCURRENCE OF METHANE GAS

MAP NO.	COUNTY COAL REGION (FIELD) MINE NAME (A) = active mine	MINE LOCATION (Sec., Twp., Rge.) (Location of entry underlined)	NAME OF MINED BED	COAL BED THICKNESS	OVERBURDEN THICKNESS (FT) (U) - Unknown	SHAFT DEPTH (FT)	COAL RANK (1)
10	Oakdale	9,10,15,16,29S-69W	Mammoth	4-13	100-500		B
11	Pictou	6,7,28S-66W 1,2,28S-67W 31,27S-66W 36,27S-67W	Walsen Cameron Robinson	12	(U)		B
12	Solar	19,28S-66W		4.5	(U)		B
	JEFFERSON						
	Denver(Boulder-Weld)						
1	Leyden #3	21,22,26,27,28,34,2S-70W	Leyden	7.7	700-792	787	SB
2	Leyden	26,27,2S-70W		9		792	SB
	LA PLATA						
	San Juan(Durango)						
1	Burnwell #1	29,35N-11W		6.5	70-110		B-hv
	Burnwell #2	29,32,35N-11W		6.5	70-110		B-hv
3	Champion	31,34½N-9W 31-35N-9W		3.5-4	180		B
4	Hesperus(old) #1 & 2	14,15,22,23,35N-11W		5-6.7	100-200		B-hv
5	King Coal (A)	31,32,35N-11W		6	(U)		B-hv
	LAS ANIMAS						
	Raton(Trinidad)						
1	Allen (A)	21,22,23,26,27,28,33S-68W	Allen or Circula	5	100-2500+		B-hv
2	Bear Canon #3	2,11,12,32S-65W	Cass ?	5	100-200		B-hv
3	Berwind (4 entries)	30,31,31S-64W 6,32S-64W 1-32S-65W 25,36,31S-65W	L. Ludlow or Berwind	5-6	(U)		B-hv
4	Boncarbo	31,32,36,32S-65W	Primero	5.2	150-500		B-hv
5	Bowen	24,32S-64W		7-8	(U)		
6	Brodhead #9	17,18,19,20,30S-65W	Brodhead #4	4	700		B
7	Cokedale #1 & 2	30,31,33S-64W 25,26,33S-65W	Cokedale	6-7	40-60		B
8	Cuatro	31,32,34S-64W		4	(U)		B

IN COLORADO COAL MINES

DAILY PRODUCTION SHORT TONS (1st qtr., 1977)	AVERAGE METHANE EMISSION CU.FT./DAY (1st quarter, 1977)	CU.FT.GAS/TON OF COAL MINED	COAL ANALYSIS-DRY(MOIST & BTU-AS RECV'D) MOISTURE (AVE.) (Ad-Rec'd.)	SULFUR (AVE.) (Dry)	ASH (AVE.) (Dry)	VOLATILE MATTER (AVE.)	FIXED CARBON (AVE.) (Dry)	BTU/LB (AVE.) (As rec'd)	OCCURRENCE OF GAS IN MINES(2) (YEAR)	MAP NO.
Closed									GE(1908),GE(1919)	10
Closed									GE(1902)	11
Closed									GE(1909)	12
Closed									G	1
Closed			19.5	.4	5.7	40.1	54.0	9724	MF(1910)	2
Closed			5.0	1.1	5.2	40.4	54.4	13250	GE(1966)	1
Closed			3.9	.6	6.2	39.6	54.0	13316	G	2
Closed									GE(1908)	3
Closed			6.4	.5	10.0	39.2	50.6	12230	MF(1953)	4
			4.6	1.0	6.3	40.5	53.1	13155	G	5
2,596 (4th qtr. 1976)	428,000	164.8	3.9	.5	21.4	34.4	44.1	11258	G GE(1956)	1
Closed									GE(1926)	2
Closed			2.5	.6	15.4	32.7	51.8	12103	GE(1917)	3
Closed			4.4	.6	14.4	33.1	52.4	12237	GE(1947)	4
									DE(1902)	5
Closed									GE(1902) MF(1907)	6
Closed									DE(1911)	7
Closed									GE(1906)	8

TABLE 1: OCCURRENCE OF METHANE GAS

MAP NO.	COUNTY COAL REGION (FIELD) MINE NAME (A) - active mine	MINE LOCATION (Sec., Twp., Rge.) (Location of entry underlined)	NAME OF MINED BED	COAL BED THICKNESS	OVERBURDEN THICKNESS (FT) (U) = Unknown	SHAFT DEPTH (FT)	COAL RANK (1)
9	Daisy #1 & 2	32-30S-64W		3	(U)		B-hv
10	Delagua	5,31S-65W 3,4,9,10,11,15,16,21,22,31S-65W	Delagua	5.8-7.8	300-700		B-hv
11	Empire	28,29,30,33,34,30S-65W	Walsen	5.6-6	600		B
12	Engle	28,29,30,31,32,36,33S-63W 31,32,33S-65W	Engle	6.5-8	(U)		B-hv
13	Frederick	5,6,7,8,9,17,34S-65W	Frederick	3.5-5.6	80-120		B-hv
14	Greenville	30,31S-64W	Berwind	6-7	(U)		B
15	Hastings #3	13,31S-65W		7	(U)		B
16	Hastings #4	13,23,24,31S-65W	Berwind	8	800		B
17	Morely	31,32,34S-63W 5,6,35S-63W 36-34S-64W 1-35S-64W	Morely	4-10	250-1000		B-hv
18	Piedmont	34-33S-64W	Lower	3.7	(U)		B
19	Primero	13,14,23,24,25,26,27,33S-66W	Primero	6.5-7.2	50-850		B
20	Rapson #1	4,9,30S-65W	L. Robinson	5	(U)		B-hv
21	Rapson #2	9,30S-65W	Walsen	5	(U)		B-hv
22	Royal	20,21,28,29,30S-65W	Walsen Peerless	6	270-1000		B
23	Sopris #1	3,4,5,9,10,34S-64W 32,33,34,33S-64W	Cameron	6	(U)		B
24	Southwestern	9,16,30S-65W	Walsen	4	(U)		B-hv
25	Starkville (9 mines)	4,5,6,34S-63W 31,32,33,34S-63W 1-34S-64W 36-33S-64W	Engle- Starkville	4-6	150-1000		B-hv
26	Tabasco	25,26,35,36,31S-65W	Hastings	5.3-8.6	1000	Natl. Coke	B
27	Tercio	21,22,34S-68W	#2 & #3	#2)6.7 #3)3.6	(U)		B
28	Toller	35,36,31S-65W 1,2,11,32S-65W	Berwind	5-7	350-400 1000	350	B
29	Victor #3	13,31S-65W		7	(U)		B

IN COLORADO COAL MINES

DAILY PRODUCTION SHORT TONS (1st qtr., 1977)	AVERAGE METHANE EMISSION CU.FT./DAY (1st qtr., 1977)	CU.FT.GAS/TON OF COAL MINED	COAL ANALYSIS-DRY(MOIST & BTU-AS RECV'D) MOISTURE (AVE.) (As-rec'd.)	SULFER (AVE.) (Dry)	ASH (AVE.) (Dry)	VOLATILE MATTER (AVE.)	FIXED CARBON (AVE.) (Dry)	BTU/LB (AVE.) (As-rec'd)	OCCURRENCE OF GAS IN MINES (2) (YEAR)	MAP NO.
Closed			2.6	.6	14.0	36.2	49.7	12290	GE(1940)	9
Closed			2.4	.7	15.9	36.2	47.8	12110	GE(1910)	10
Closed									GE(1919)	11
Closed			2.8	.6	13.7	30.5	55.6	12545	GE(1906) MF(1907)	12
Closed			1.8	.6	16.4	30.3	53.2	12518	G	13
Closed									DE	14
Closed									G GE(1912)	15
Closed									G GE(1917)	16
Closed			1.8	.8	15.4	31.6	52.9	12610	G DE(1909)	17
Closed									GE(1912)	18
Closed									GE(1907) 1910)	19
Closed			2.7	.6	4.8	37.1	52.1	12772	G	20
Closed			2.5	.6	13.2	36.2	50.5	12517	G	21
Closed									GE(1914) MF(1911)	22
Closed									GE(1895 1922)	23
Closed			2.8	.6	11.9	33.4	54.6	12656	GE(1923)	24
Closed			1.9	.7	18.3	30.1	51.4	12288	GE(1888) MF(1910-1911) GE or DE (1910)	
Closed									GE(1906)	26
Closed									DE(1904)	27
Closed									GE(1909) GS(1913)	28
Closed									DE(1910) MF(1910)	29

TABLE 1: OCCURRENCE OF METHANE GAS

MAP NO.	COUNTY COAL REGION (FIELD) MINE NAME (A) = active mine	MINE LOCATION (Sec., Twp., Rge.) (Location of entry underlined)	NAME OF MINED BED	COAL BED THICKNESS (FT)	OVERBURDEN THICKNESS (FT) (U) = Unknown	SHAFT DEPTH (FT)	COAL RANK(1)
	MESA						
	Uinta-Piceance (Book Cliffs)						
1	Cameo (A)	27,28,33,34,10S-98W	Cameo	6-9.5	2000		B-hv
	(Grand Mesa)						
2	Grandview	11,11S-98W		4-5			B-hv
	(Book Cliffs)						
3	McGinley (A)	5,9S-100W	Cameo	11	500		B-hv
	(Grand Mesa)						
4	Midwest	10,11,11S-98W	Palisade	4.8	100		B
	(Book Cliffs)						
5	Palisade	3,4,5,11S-98W	Palisade	3-4	(U)		B-hv
	MOFFAT						
	Uinta-Piceance (Danforth Hills)						
1	Red Wing	3A,4,35,4N-93W 2,3-3N-93W	Collum	23	100-1000		B-hv
	(Yampa)						
2	Wisconsin	6-6N-93W 31-7N-98W		8.3	(U)		B
	PARK						
	South Park (South Park)						
1	Como	2,11,9S-76W		7	(U)		SB
2	Como #5	2,9S-76W		4-6	(U)		SB
	PITKIN						
	Uinta-Piceance (Carbondale)						
1	Bear Creek (A)	21,10S-89W	Coal Basin "B"	7	200-1500		B-mv
2	Coal Basin (A)	5,8,10S-89W	Coal Basin "B" and "C"	6.9-8	150-600		B-mv
3	Dutch Creek #1 (A)	17,10S-89W	Coal Basin "B"	7	0-2100		B-mv
4	Dutch Creek #2 (A)	17,10S-89W	Dutch Creek	7	1370-1800		B-mv

IN COLORADO COAL MINES

DAILY PRODUCTION SHORT TONS (1st qtr., 1977)	AVERAGE METHANE EMISSION CU.FT./DAY (1st qtr., 1977)	CU.FT.GAS/TON OF COAL MINED	COAL ANALYSIS-DRY(MOIST & BTU-AS REC'D) MOISTURE (AVE.) (As-rec'd)	SULFER (AVE.) (Dry)	ASH (AVER.) (Dry)	VOLATILE MATTER (AVE.)	FIXED CARBON (AVE.) (Dry)	BTU/LB (AVE.) (As-rec'd)	OCCURRENCE OF GAS IN MINES (2) (YEAR)	MAP NO.
			7.5	.6	11.3	38.0	50.6	11659	G	1
Closed									GE(1908)	2
			8.5	.6	8.9	38.7	54.1	11723	G	3
Closed									GE(1923)	4
Closed			7.7	.8	8.9	40.0	51.0	12037	MF(1900)	5
Closed			11.4	.4	3.7	42.6	53.5	11646	MF(1974)	1
Closed									MF(1944)	2
Closed									G GE(1885)	1
Closed									GE(1890) DE(1893)	2
480	885,000	492 1843.7	4.0	.5	4.6	25.3	70.1	14680	G	1
431	1,750,000	1821 4060.3	4.2	.6	9.6	23.0	67.3	13590	G	2
642	2,235,000	2631 3481.3	3.9	.6	8.2	22.9	68.8	13940	GE(1965) DE(1957)	3
1008	1,489,000	867.7 1477.1	3.8	.6	4.2	21.4	74.1		G	4

TABLE 1: OCCURRENCE OF METHANE GAS

MAP NO.	COUNTY COAL REGION (FIELD) MINE NAME (A) = active mine	MINE LOCATION (Sec., Twp., Rge.) (Location of entry underlined)	NAME OF MINED BED	COAL BED THICKNESS (FT)	OVERBURDEN THICKNESS (FT) (U = Unknown)	SHAFT DEPTH (FT)	COAL RANK (1)
5	L. S. Wood(A)	8,10S-89W	Coal Basin "B"	7	0-1650		B-mv
6	Placita (old)	6,11S-88W		3.4	200?		B
7	Spring Gulch	15,22,23,26,27-8S-89W	Anderson Allen	4.5-6 8-11.5	0-1000		B
8	Thompson Creek #1 (A)	34,35,8S-89W	"A" "B"	8 8	300+ 300+		B-hv B-hv
9	Thompson Creek #2 (A)	34,35,8S-89W	"A" & "B"	7	80-100		B-hv
10	Thompson Creek #3 (A)	34, 8S-89W	Sunshine	9	(U)		B-hv
	RIO BLANCO						
	Unita-Piceance (Lower White) (River)						
1	White River	2,10,11,2N-101W		7.8	(U)		B-hv
	ROUTT						
	Green River (Yampa)						
1	Apex #2(A)	22,4N-86W	Pinnacle	4.5	(U)		B-hv
2	Babson	4,5N-88W		10.5	(U)		B-hv
3	Oak Hills #2	27,8N-87W	Pinnacle	10-12	(U)		B-hv
4	Wadge #1 & #2	9,10,15,6N-87W	Wadge	8.5	#1)400-500 #2)200-400		B-hv
	WELD						
	Denver (Boulder-Weld)						
1	Boulder Valley (old)	18,1N-68W		6.6-10.3	316		SB
2	Boulder Valley (new)	17,20,21,1N-68W		10	350		SB
3	Boulder Valley #3	1,1N-68W		6.5	245		SB

IN COLORADO COAL MINES

DAILY PRODUCTION SHORT TONS (1st qtr., 1977)	AVERAGE METHANE EMISSION CU.FT./DAY (1st qtr., 1977)	CU.FT.GAS/TON OF COAL MINED	MOISTURE (AVE.) (As-rec'd)	SULFER (AVE.) (Dry)	ASH (AVE.) (Dry)	VOLATILE MATTER (AVE.)	FIXED CARBON (AVE.) (Dry)	BTU/LB (AVE.) (As-rec'd)	OCCURRENCE OF GAS IN MINES (2) (YEAR)	MAP NO.
1800	1,867,000	2087 1037.2	3.0	.8	7.8	22.6	69.6	14521	G	5
Closed									GE(1923)	6
Closed									DE(1901)	7
113	18,000		3.5	1.2	14.1	30.3	55.6	12830	GE(1956)	8
		159.2	2.6	1.0	8.9	30.8	60.3	13740		
Closed			3.1	1.1	12.3	29.5	58.2	13220	G	9
?	None		2.9	.7	7.8	33.6	58.5	13745	G	10
Closed			11.0	.4	7.9	39.3	53.0	10682	G	1
60(1974)	11,400(1974)	190	9.1	.5	5.4	41.2	53.2	12008	GE or DE (1943)	1
Closed			14.1	.4	6.4	37.6	55.9	10864	MF(1965)	2
Closed			8.1	.6	6.5	40.7	52.6	12031	DE(1921)	3
Closed			9.6	.5	7.8	40.0	52.1	11517	GE(1942)	4
Closed									G	1
Closed									G	2
Closed			23.5	.5	6.3	38.9	54.7	9447	G	3

TABLE 1: OCCURRENCE OF METHANE GAS

MAP NO.	COUNTY COAL REGION (FIELD) MINE NAME (A) = active mine	MINE LOCATION (Sec., Twp., Rge.) (Location of entry underlined)	NAME OF MINED BED	COAL BED THICKNESS (FT)	OVERBURDEN THICKNESS (FT) (U = Unknown)	SHAFT DEPTH (FT)	COAL RANK(1)
4	Eagle (A)	14,15,22,1N-68W	Laramie #3	9		370	SB
5	Imperial	10,11,1N-68W		10.5	270	2790	SB
6	Lincoln	13,24,1N-68W		8-10		425	SB
7	Parksdale	6-1S-68W 31-1N-68W		7-10			SB
8	Russell	20,29,2N-67W		6	300	220	SB
9	Sterling	31,32,2N-67W 6,7-1N-67W		7.9	340-360	358	SB
10	Washington (new)	22,23,26,27,28,1N-68W		8-12		430	SB

ADDENDUM

None	Delta County Uinta Region, Grand Mesa Field Orchard Valley Mine	24,13S,92W	"B"	27' avg.	450'-1800'	Bit
	Gunnison County Uinta Region, Somerset Field Hawk's Nest West	12,13S,90W	"E"	8-9'	1600'-2000'	hvB
	Hawk's Nest East	11,13S,90W	"E"	7-9'	1600' max	hvB
	Uinta Region, Crested Butte Field O.C. Mine #2	16,15S,86W	"C" Kubler	5.5-6.0'	1800'-2000'	Bit
	Mesa County Uinta Region, Book Cliffs Field C.M.C. Mine	34,10S,98W	Cameo "B"	7'	<1800'	hvB

(1) A = anthracite
B = bituminous
SB = subbituminous

hv = high-volatile
mv = medium-volatile
lv = low-volatile

(2) G = gassy mine
GE = gas explosion
GS = gas suffocation
DE = dust explosion (methane related?)
MF = mine fire

Note: Numerous minor mine explosions are not listed.

IN COLORADO COAL MINES

DAILY PRODUCTION SHORT TONS (1st qtr., 1977)	AVERAGE METHANE EMISSION CU.FT./DAY (1st qtr., 1977)	CU.FT.GAS/TON OF COAL MINED	MOISTURE (AVE.) (As-rec'd)	SULFER (AVE.) (Dry)	ASH (AVE. (Dry)	VOLATILE MATTER (AVE.)	FIXED CARBON (AVE. (DRY)	BTU/LB (AVE.) (As-rec'd)	OCCURRENCE OF GAS IN MINES (2) (YEAR)	MAP NO.
250(1st qtr.,1976)	7,000	28,4.6	21.3	.4	6.0	38.9	55.3	9840	G	4
Closed			21.7	.4	6.0	38.7	55.0	9761	G	5
			24.3	.4	7.3	37.9	54.7	9330	G	6
Closed									GS(1915)	7
Closed			23.2	.6	6.8	38.3	54.7	9482	MF(1947)	8
Closed			24.5	.5	6.0	36.4	55.1	9313	G	9
Closed			21.5	.4	6.3	38.8	54.8	9636	GE(1946)	10

None

600	None	0	10-11	.4	3.4			12,000	
800	425,000	531	4.4-7.1	.3-.5	3.2-9.1			12,400-13,400	
150	29,000	193	Unknown	.3-.5	5-7			12,500	
20	None	0	9.5-10.1	.3-.6	4.3-6.0			11,840	
300	24,00	80	5-6	.4-.6	7-11			11,990-13,011	

DESORPTION DATA FOR METHANE GAS FROM COLORADO COAL CORES

TEST NO.	COAL REGION / FORMATION / COAL FIELD	GEOLOGIC FORMATION AGE	COAL BED NAME	DATE SAMPLED	SURFACE ELEVATION	DEPTH TO BED (FT.)	BED THICKNESS (FT.)	SAMPLE WEIGHT (GRAMS)	TEST PERIOD (DAYS)	GAS DESORBED (CM^3)
	SAN JUAN RIVER REGION									
1	Durango Field	Menefee Fm (U. Cret.)	unknown	2/3/76	7800±	295	9.0±	1336	35	105[1]
2	Durango Field	Menefee Fm (U. Cret.)	unknown	2/4/76	7520	310	7.5	1318	34	91[2]
	RATON MESA REGION									
3	Walsenburg Field	Vermejo Fm (U. Cret.)	Prior(above Walsen)	6/9/76	6440	111	4.0	1049	28	51[1]
4	Walsenburg Field	Vermejo Fm (U. Cret.)	Walsen(below Prior)	6/10/76	6440	155	6.0	1211	27	82[1]
	GREEN RIVER REGION									
5	Yampa Field	Williams Fork Fm (U. Cret.)	Wadge	8/23/76	7000	1283	11.5	1560	10	0[2]
6	Yampa Field	Williams Fork Fm (U. Cret.)	Wadge	8/26/76	6860±	1393	11.0	1126	13	49[1]
7	Yampa Field	Williams Fork Fm (U. Cret.)	U.Wolf Creek	9/18/76	6810	488	1.3	852	15	32[2]
8	Yampa Field	Williams Fork Fm (U. Cret.)	Wadge	9/19/76	6810	335	8.5	1233	16	165[1]
9	Yampa Field	Williams Fork Fm (U. Cret.)	Upper "A" Wolf Creek	10/5/76	6800?	1104	4.5	1038	9	112[1]
10	Yampa Field	Williams Fork Fm (U. Cret.)	Lower "A" & "B" Wolf Creek	10/6/76	6800?	1123	9.7	1442	8	118[2]
	UINTA REGION									
11	Danforth Hills Field	Williams Fork Fm (U. Cret.)	unknown	7/9/77	7049	2216	15	329	23	177[1]
12	Danforth Hills Field	Williams Fork Fm (U. Cret.)	unknown	7/9/77	7049	2243	4	486	23	153[1]
13	Danforth Hills Field	Williams Fork Fm (U. Cret.)	unknown	7/9/77	7140	2122	12	679	23	234[2]
14	Danforth Hills Field	Williams Fork Fm (U. Cret.)	unknown	8/4/77	7029	2106	8	725	17	74[2]
15	Danforth Hills Field	Williams Fork Fm (U. Cret.)	"J-J"	9/24/77	7640	48.7	10.8	863	23	1
16	Danforth Hills Field	Williams Fork Fm (U. Cret.)	"J-J"	9/28/77	7200	502.6	12	797	23	0
17	Grand Mesa Field	Williams Fork Fm (U. Cret.)	"D"	6/30/77	7720	504	5.8	773	30	116[2]
18	Grand Mesa Field	Williams Fork Fm (U. Cret.)	unknown	9/20/77	6750	706.7	7.6	238	32	1018
19	Grand Mesa Field	Williams Fork Fm (U. Cret.)	unknown	9/20/77	6750	706.7	7.6	396	32	225

Footnotes:

1 Stopped test due to low gas emission rate.
2 Residual gas calculated with a non-useable formula.
3 New formula used to calculate "lost" gas when a cylinder went on a vacuum.
4 Cylinder went on vacuum when moved from coring site to Denver.

DESORPTION DATA FOR METHANE GAS IN COAL (CONTINUED)

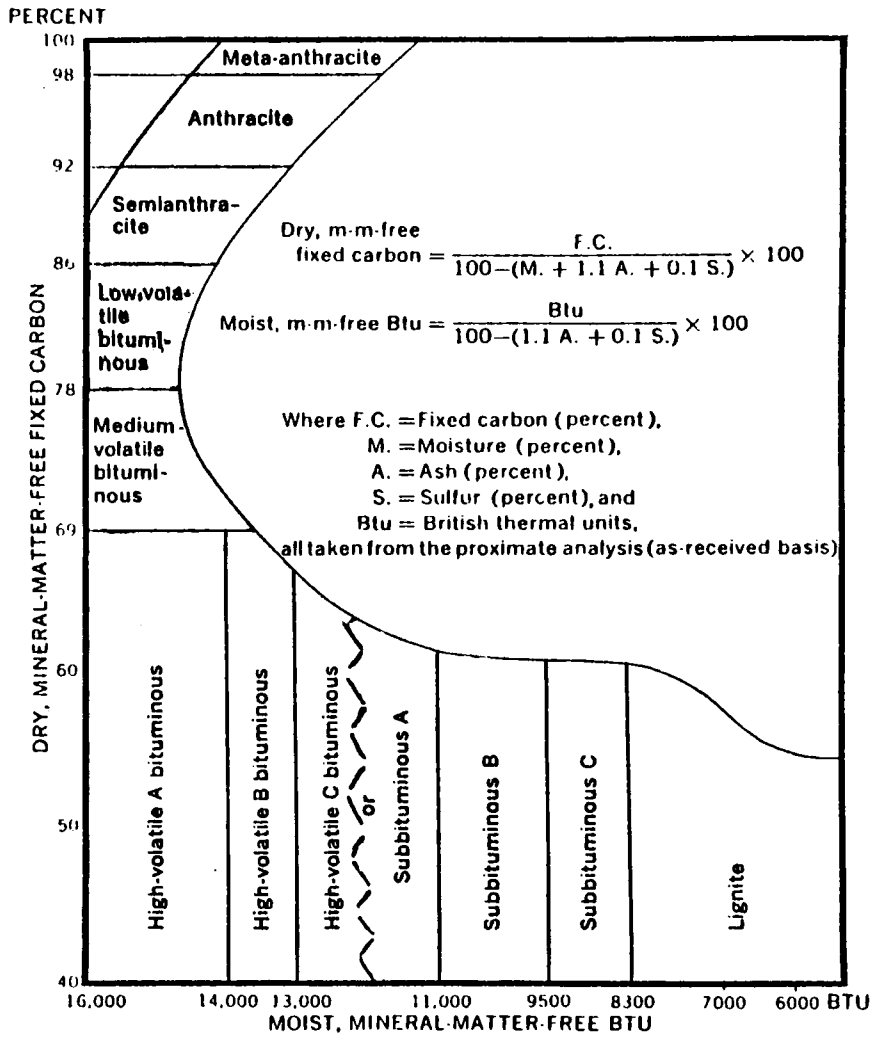
LOST GAS CM^3	CALCULATED RESIDUAL + DESORBED + LOST GAS (CM^3)	FT^3 METHANE/TON COAL (CM^3/G)	CYLINDER WENT ON VACUUM[4]	ANALYSIS (as received-basis) ULTIMATE CARBON %	VOLATILE MATTER %	ASH %	MOISTURE %	SULFUR %	HEATING VALUE (BTU/LB)	APPARENT RANK OF COAL
40	225[2]	5.3 (.17)	Yes	71.0	34.7	9.7	3.4	.7		
145	421[2]	10.2 (.32)	Yes	65.2	32.0	17.2	3.1	.7		
75	984[2&3]	29.7 (.07)	Yes	64.4	37.0	11.1	7.5	.7	12971	hvCBit.
241	1313[2&3]	34.6 (1.08)	Yes	63.2	36.4	13.0	6.8	.6	12943	hvCBit.
Not calculated	Not calculated	Not calculated	Yes	66.9	34.2	7.5	8.2	.5	12917	hvCBit.
45	541[2&3]	15.3 (.48)	Yes	67.4	35.6	6.4	8.2	.4	12922	hvCBit.
Not calculated	Not calculated	Not calculated	Yes	66.6	35.2	5.1	9.6	.6	12465	hvCBit.
62	302[2]	7.7 (.24)	No	65.1	33.9	7.8	8.8	.6	12590	hvCBit.
Not calculated	Not calculated	Not calculated	Yes	72.7	36.0	5.7	4.5	.5	13902	hvBBit.
Not calculated	Not calculated	Not calculated	Yes	composited with No. 9						
0	177	16 (.50)	Yes	confidential						
460 (?)	613	41.6 (1.31)	Yes							
284 (?)	518	31.4 (.98)	Yes							
0	74	3.3 (.10)	Yes							
Not calculated	0	0 (0)	Yes	61.8	33.2	3.3	16.1	.4	10997	hvCBit
Not calculated	0	0 (0)	Yes	63.8	32.4	4.1	14.4	.3	11368	hvCBit
Not calculated	149	6.4 (0.19)	Yes	67.9	37.8	3.7	10.8	.4	12337	hvCBit
320	1338	179.2 (5.62)	Yes	59.3	30.9	11.7	11.8	.7	12007	hvCBit
100	325	25.6 (.82)	Yes	composite with #18						

TABLE 3: DATA FROM EXAMINED COAL MINES

MINE NAME	CLEAT ORIENTATION	MINING PROBLEMS	MOISTURE %	VOLATILE MATTER %	FIXED CARBON %	ASH %	SULFUR %	HEATING VALUE BTU/LB	FSI
Bear Mine	Cleat Strike-Face N46°E Dip-approx. 90° Spacing - varied Well developed bedding - No info.	Mining toward west. East side closed due to .3-1.0 (1.5%) methane Fault near east side of workings Not exposed	4.5-7.0	39.6-42.4	52.1-55.4	2.8-8.9	.4-1.0	12,170-13,430	1-2.5
Hawk's Nest #3	Cleat-face N50°E Dip 90° Spacing .04'-1.0' Well developed bedding - no info.	No problems mentioned in field notes.	4.4-7.1	38.7-42.5	51.5-56.6	3.5-6.3	.4-.6	12,400-13,400	1.0-3.0
Somerset Mine	Cleat: Strike Face N29-49°E Dip 72°-86°SE Strike-Butt-N45°-55°W Dip 52-55° SW Bedding-Strike NW Dip 6°NE	"B" Seam has Lt. gray SS dike (spars) occuring occasionally coming up from the floor and sometimes extending through the seam to the roof rock contact.	4.5-7.1	38.2-40.4	48.1-54.3	7.9-12.0	.4-.6	12,070-12,990	1.5-3.0
CMC Mine	Cleat-Strike-Face N37°E Dip 90° Spacing-varied well developed Strike-Face-N53°W Dip 90° Moderately well developed Bedding N65°W Dip N25°E	No problems mentioned in field notes.	5.0-6.0	35.4	47.3	7-11	.4-.6	11,990-13,010	1.0
Dutch Creek #1	No cleat orientation Bedding-Strike N-NE Dip 13°NW	High methane content of coal	4.5-7.0	39.6-41.9	51.5-54.0	3.2-7.2	.4-.6	13,980-15,200	2.5-9.

Analyses obtained from published analyses from U. S. Bureau of Mines (1973)

Table 4. Classification of coals by rank



BASIS OF RANK CLASSIFICATION OF COALS IN THE UNITED STATES, AND THE FORMULAE USED IN MAKING APPROXIMATE RANK DETERMINATIONS

Determinations based on the above cannot be considered final or even adequate for any but the most general application. For further information, see the Standard Specifications for Classification of Coals by Rank of the American Society for Testing Materials, A.S.T.M. designation D388-38.

(from J. Trumbull, 1960, Coal fields of the United States, Sheet 1, U. S. Geological Survey)

FORM 1

STATE OF COLORADO

RICHARD D. LAMM
GOVERNOR

JOHN W. ROLD
Director

COLORADO GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES
715 STATE CENTENNIAL BUILDING — 1313 SHERMAN STREET
DENVER, COLORADO 80203 PHONE (303) 892–2611

The Colorado Geological Survey is currently conducting studies on several coal projects which should be of interest to all companies involved with exploring for and mining Colorado coal.

This letter contains a brief description of each project so that you may be cognizant of this work. It may be that your company will never be involved in all phases of these projects.

I should emphasize that designated confidential information will be kept as such by all concerned parties until your permission for release has been given. Also, any coal samples, cores, or other related data that your company provides which are used for analyses, desorption, or other tests will entitle your company to copies of the results at no charge.

The projects consist of the following three Federal grants and one State-generated tabulation:

Colorado Coal Directory Data - (State)

Enclosed you will find a partially filled out self-explanatory form for active and/or proposed coal mines, whichever is applicable to your company. We will appreciate any additions or corrections you may wish to make. We will honor the confidentiality of any items so marked. The "consumer contracts" data may require a separate sheet. For companies operating more than one mine, additional forms are enclosed— one for each mine.

Methane Grant - (Federal)

The stated goal of this grant project is to locate an area in Colorado containing gassy coal beds which may be penetrated by a vertically drilled hole in which one or more coal beds may be hydraulically stimulated by the hydro-fracture method currently being employed by the petroleum industry to enhance the production of oil and gas.

This procedure could result in developing new reserves of pipeline-quality gas, improving mine safety, and increasing mine productivity. Fracture treatments in other areas of the country have increased the flow of methane from coal beds by several fold.

If successful, this project could be invaluable to coal companies. To a large degree, the success of this project depends upon the willingness of coal companies to provide information such as sample logs, core logs, mine maps, tonnage figures, and portions of freshly-cut cores. Core splits from freshly-cut cores are needed to calculate the cubic feet of gas contained in a ton of coal. The procedure is to seal the coal splits in a cylinder at the drill site. Gas is released from the cylinder each day and measured. This data applied to a formula will show the cubic feet of gas in place per ton of coal. The desorbing process takes about three weeks.

Upon completion of the test, and if the company so desires, the U.S.G.S. will run trace element analyses, and the U.S.B.M. will perform the usual proximate and ultimate analyses, etc. on the degasified core.

Coal Sampling Grant - (Federal)

The purpose of this grant is to collect coal samples from each active coal mine in Colorado, and from cores of coals likely to be mined in the future. The U.S.G.S. will run trace element analyses, and the U.S.B.M. will run the conventional proximate, ultimate, etc. analyses.

Coking Coal Grant - (Federal)

The purpose of this grant is to determine which coals in Colorado are favorable for coking. Data needed include thickness of beds, depth to beds, areal extent of beds, estimated reserves, and other factors. This project requires that coal samples be taken from cores or from underground mines.

Calculation of Remaining Coal Reserve Base in Colorado by Coal Bed and County - (Federal)

The purpose of this grant is to compile data on mined or potentially mineable coal by bed and by county; to determine the amount of coal mined to date, and to determine the remaining coal reserves in each county, by coal bed or zone. Detailed information desired would include the name of the coal bed, thickness, depth, and areal extent of the bed.

The Colorado Geological Survey will be most grateful for whatever support the coal industry of Colorado can provide in order that these projects may be successfully completed.

Sincerely,

D. Keith Murray
Mineral Fuels Section

HBF/DKM/jp

STATE OF COLORADO

RICHARD D. LAMM
GOVERNOR

JOHN W. ROLD
Director

COLORADO GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES
715 STATE CENTENNIAL BUILDING – 1313 SHERMAN STREET
DENVER, COLORADO 80203 PHONE (303) 892–2611

DATA ACCUMULATION ON THE METHANE POTENTIAL OF THE COAL BEDS OF COLORADO

U.S. Bureau of Mines Grant No. G-0166008, awarded to the Colorado Geological Survey (Grant term October 1, 1975-September 30, 1977)

DESCRIPTION OF PROJECT

Goal:

The goal of this grant project is to locate an area in Colorado containing gassy coal beds that may be penetrated by a hole drilled vertically to a reasonable depth in which one or more coal beds may be stimulated by the hydraulic fracturing method currently being employed by the petroleum industry. This treatment usually enhances production.

Results:

Successful completion of the methane project could result in the development of new reserves of pipeline-quality gas, improvement of mine safety, and increases in mine productivity.

Data desired for the project:

1. Drill hole sample logs
2. Core logs
3. Geophysical well logs
4. Cleat direction
5. Two or more 5' coal seams
6. Seam depths from 900'-1500'
7. Coal seams to extend over extensive area
8. Portions of freshly cut cores for methane desorption
9. Mine maps
10. Coal reserve data
11. Tonnage produced
12. Any gas problems
13. Near a town
14. Near a gas pipeline

Desorption procedure:

Splits from freshly cut cores are needed to calculate the cubic feet of gas contained in a ton of coal. The procedure is to seal in a cylinder the coal splits as soon as possible after retrieval from the core barrel at the drill site. Gas released from the cylinder is measured at regular intervals. The cubic feet of gas in-place per ton of coal can thus be calculated from the resulting data. The amount of core required for desorption is 1000+ grams. The desorption process takes about 3 weeks.

Analysis:

Upon completion of the desorption process, and if the operator so desires, the U.S. Geological Survey will run trace element analyses on one portion of the degasified core, and the Bureau of Mines will perform conventional (proximate, ultimate, etc.) analyses on a second split. Approximately 4 to 5 months generally are required before the final analyses have been completed and sent to the Colorado Geological Survey. If a company prefers to have the analyses run by their own commercial contractor, the desorbed portion of the core can be returned to the company with no alteration other than the desorption of most of the contained methane. The desorption and/or analytical data from any core sample provided to the Colorado Geological Survey will be available at no cost to the company involved.

Confidentiality

All resulting data will be kept confidential until the operator grants permission for its release.

Notice for Collecting Cores

It is preferred that we be notified at least one day prior to the day of the coring operation in order that CGS personnel can be at the drill site prior to penetration of the coal bed.

Should your company wish to cooperate in this methane-in-coal project, please contact either of the following:

D. Keith Murray, Principal Grant Investigator
(office, 892-2611; home, 233-6422)
H. B. Fender, Assistant Grant Investigator
(office, 892-2611; home, 421-8153)

H. B. Fender

H. B. Fender
Assistant Grant Investigator

HBF/ef

PRODUCING/LICENSED COAL MINE DATA SHEET

COUNTY:

COAL REGION:

FIELD NAME:

MINE NAME:

LOCATION (Active surface operation or underground entry): *mi.* *of* *Sec.*_____ *Twp.*_____ *Rge.*_____

TYPE OF MINE:

MINING METHOD:

STARTUP DATE:

DEPTH OR OVERBURDEN:

NAME OF COAL BED(S):

GEOLOGIC FORMATION/ROCK UNIT:

GEOLOGIC AGE:

THICKNESS OF COAL BED(S), FEET:

DIP, DEGREES:

RANK OF COAL:

USE OF COAL:

PROXIMATE ANALYSIS (AS-RECEIVED):

Heat value, Btu/lb.:
Sulfur, %:
Moisture, %:
Ash, %:

MINE OPERATOR(S):

(name)
(address)

(telephone no.)

CORPORATE AFFILIATION:

COMPANY OFFICIALS:

LEASE INFORMATION:

PRODUCTION DATA (SHORT TONS):
Cumulative to 1/1/77:
1975
1976
1977 (est.)
197_ (projected)
19___(projected)

NUMBER OF EMPLOYEES:
1975
1976
1977(est.)
197__ (projected)
19___ (projected)

ESTIMATED LIFE/RESERVES:

SALES DATA:

PROPOSED COAL MINE DATA SHEET

COUNTY:

COAL REGION:

FIELD NAME:

MINE NAME:

LOCATION (Active surface operation or underground entry): *mi.* *of* *Sec.*_____ *Twp.*_____ *Rge.*_____

TYPE OF MINE:

MINING METHOD:

STARTUP DATE:

DEPTH OR OVERBURDEN:

NAME OF COAL BED(S):

GEOLOGIC FORMATION/ROCK UNIT:

GEOLOGIC AGE:

THICKNESS OF COAL BED(S), FEET:

DIP, DEGREES:

RANK OF COAL:

USE OF COAL:

PROXIMATE ANALYSIS (AS-RECEIVED):

Heat value, Btu/lb.:
Sulfur, %:
Moisture, %:
Ash, %:

MINE OPERATOR(S):

(name)

(address)

(telephone no.)

CORPORATE AFFILIATION:

COMPANY OFFICIALS:

LEASE INFORMATION:

PRODUCTION DATA (SHORT TONS):

19__ (projected)

19___ (projected)

NUMBER OF EMPLOYEES:

19__ (projected)
19___ (projected)

ESTIMATED LIFE/RESERVES:

SALES DATA:

STATUS OF MINE:

FORM 5

CORE SAMPLE DATA SHEET

Company Drill Hole No. (Sample No.)_____ Date_____
(tape Company Name and Drill Hole No. on cylinder)
Company_____ Person Collecting Core_____

Drilling Company_____

Hole Location_____

County_____ State_____

Core Size_____ Barrel Length_____ Type of Core Retrieval_____

Drilling Media_____ Air Temperature_____ Surface Elevation_____

Coalbed_____ Coal Thickness_____

Depth to base of coalbed_____ Total Depth of Hole_____

Roof Rock_____

Floor Rock_____

Character and type of coal_____

Seam Description_____

Condition of Sample_____

Sampled Interval_____ Cored Interval_____

Cylinder Wt._____gm. Cylinder Wt. + Coal_____gm. Coal Sample Wt._____gm.

Time Coring Started_____ Time Coring Completed_____

Time Coalbed Encountered (A)_____ Time Core Started Out of Hole(B)_____

Time Core Reached Surface (C)_____ Time Core Sealed in Cannister (D)_____

RESULTS

Lost Gas Time: (D-A) if air or mist is used_____

$(D-C) + (\frac{C-B}{2})$ if water is used_____

$\sqrt{\text{Lost Gas Time}}$ in minutes_____ Lost gas (cm^3)_____

Gas from Canister (cm^3)_____

Residual Gas from Crushing (cm^3/g)_____

GAS CONTENT CALCULATION ($\frac{cm^3}{g}$)

$$\text{Gas Content} = \frac{\text{Lost Gas } (cm^3) + \text{Gas from Canister } (cm^3)}{\text{Sample Weight (gm)}} + \text{Residual Gas from Crushing } \frac{(cm^3)}{gm}$$

Total $cm^3/g \times 32 = Ft^3/Ton$

FORM 6

State:	County:	Location:	Hole No.:	P.

Time 0 = Date	Time	Elapsed Min.	$\sqrt{\text{T*}}$ ø	Cylinder Reading 1 ml 2	Cm^3 Gas Released	Cm^3 Total Gas ø	DER Cm^3/g ↓	Cylinder No.! Sample Wt.! Comments

* "Lost" gas time + desorption time in minutes

↓ Sample Weight $\sqrt{\text{Daily Emission}}$ = DER

R = Reverse Flow

ø Plot on Figure 4 graph

$\sqrt{\text{"Lost" Gas Time}}$ =

FORM 7

State: _____ County: _____ Loc.: _____

Co.: _____ Hole No.: _____ Cyl. No.: _____

Date Started: _____ Date Completed: _____

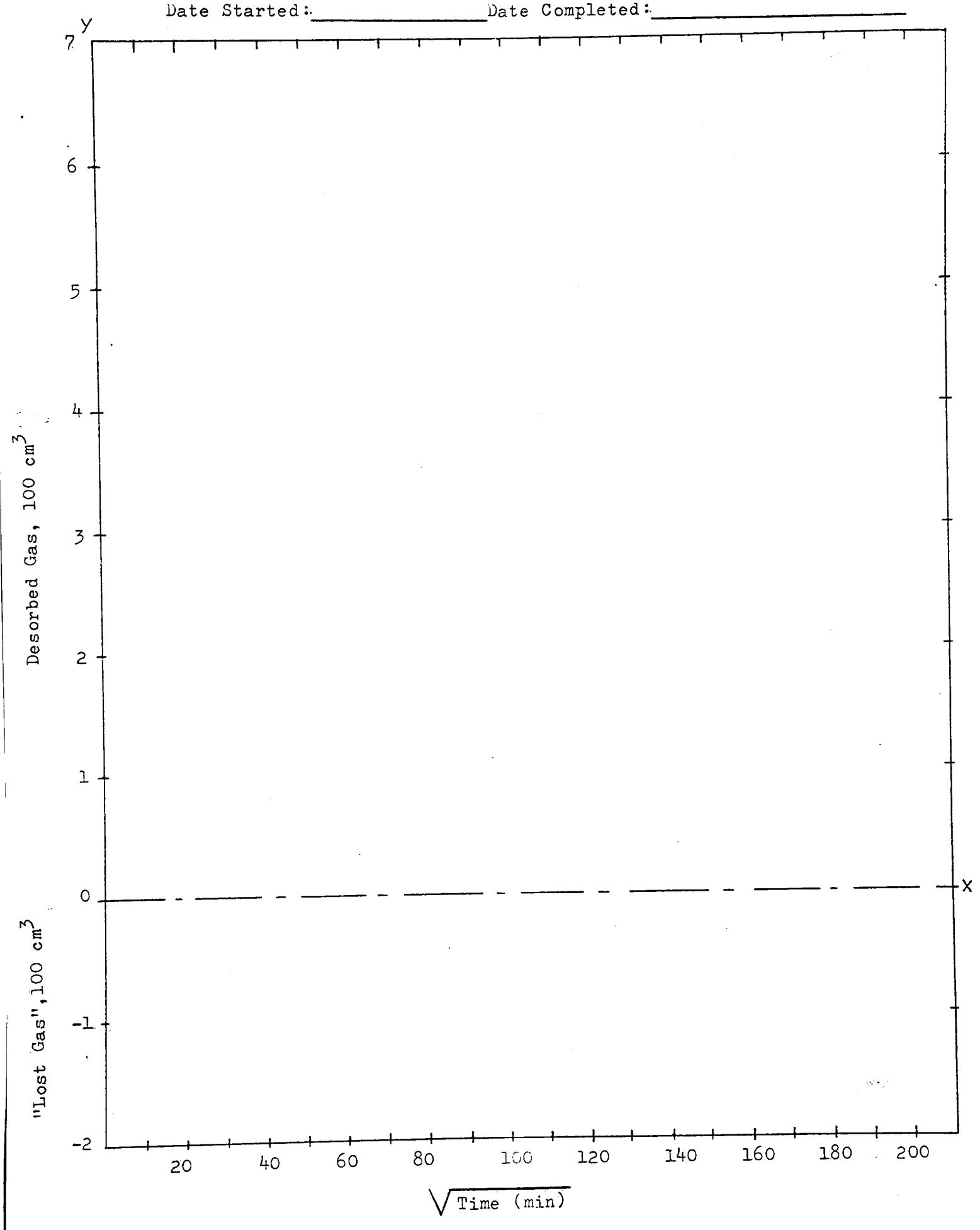


TABLE 1: OCCURRENCE OF METHANE GAS

MAP NO.	COUNTY COAL REGION (FIELD) MINE NAME (A)= active mine	MINE LOCATION (Sec.,Twp.,Rge.) (Location of entry underlined)	NAME OF MINED BED	COAL BED THICKNESS (FT)	OVERBURDEN THICKNESS (FT) (U)= Unknown	SHAFT DEPTH (FT)	COAL RANK (1)
	BOULDER						
	Denver (Boulder-Weld)						
1	Hi-Way	13,14,23,26,1S-69W	Boulder	6-7	300	385	SB-
2	Monarch #2	20,21,28,29,32,33,1S-69W	Uncorrelated	7(upper)	285-375	375	SB
3	Nonpareil	16,17,1S-69W		4(lower)	285	285	SB
4	Simpson	34,35,1N-69W 2,3,1S-69W	Simpson	6-14	225-240	240	SB
5	Standard	1,12,1S-69W	L. Lafayette	5.5-8		320	SB
6	Sunnyside	28-1S-69W		5		324	SB
	DELTA						
	Uinta (Somerset)						
1	Blue Ribbon	2, 13S-91W		6	(U)		B-hv
	Uinta (Grand Mesa)						
2	Independent	13, 13S-95W	#2	6.2	100		B-hv
	Uinta (Somerset)						
3	King (A)	9,10,11,14,15,13S-91W	Uncorrelated	16	2000		B-hv
	Uinta (Grand Mesa)						
4	Tomahawk	10,15,16,13S-95W	Green Valley	11	(U)		B-hv
	EL PASO						
	Denver (Colorado Springs)						
1	City #2	29,33,13S-66W		14		43	SB
2	Pikeview	12,13,13S-67W 7,18,13S-66W	Fox Hill	7-14		173	SB
	FREMONT						
	Canon City (Canon City)						
1	Beacon	27,19S-70W		3.5	(U)		B
2	Blue Flame Gas	12,19S-70W	Griffiths	2.2	(U)		B
3	Brookside	10,11,14,15,19S-70W	Brookside	3	(U)		B-hv
4	Canon Liberty #3	19,30,20S-69W		3.3	(U)		B-hv
5	Coal Creek #1 & 2	6,19,30,31,19S-69W,1,31,36,20S-70W	Canon	3.6-5		400	B
6	Golden Quality #1	10,20S-70W		8	(U)		B

IN COLORADO COAL MINES

DAILY PRODUCTION SHORT TONS (1st qtr., 1977)	AVERAGE METHANE EMISSION CU.FT./DAY (1st qtr., 1977)	CU.FT.GAS/TON OF COAL MINED	COAL ANALYSIS-DRY(MOIST & BTU-AS REC'D) MOISTURE (AVE.) (As-rec'd)	SULFER (AVE.) (Dry)	ASH (AVE.) (Dry)	VOLATILE MATTER (AVE.)	FIXED CARBON (AVE.) (Dry)	BTU/LB (AVE.) (As rec'd)	OCCURRENCE OF GAS IN MINES (2) (YEAR)	
Closed			20.7	.3	5.6	38.7	55.5	9933	GE(1939) MF ?	1
Closed			19.8	.5	5.2	38.8	55.9	10155	GE(1936)	2
Closed									GE(1908)	3
Closed									GE(1912)	4
Closed									GE(1908)	5
Closed									GE(1902)	6
Closed			6.4	.5	4.1	40.8	55.0	12927	G	1
Closed									MF(1930)	2
			3.9	.4	4.6	41.9	53.5	13400	G	3
			4.3	.5	5.7	41.0	53.1	13198	MF(1911)	
Closed			13.8	.8	9.3	38.4	52.3	10795	G	4
Closed									GS ?	1
Closed			23.1	.5	8.0	42.5	48.1	8730	GE(1956)	2
Closed									MF(1910)	1
Closed									GE(1941)	2
Closed			9.4	.6	9.7	38.6	51.6	11212	MF(1910) MF(1961)	3
Closed			9.7	1.1	8.7	40.4	50.8	11293	G	4
Closed									GE(1885 1886,1888)	5
Closed									G	6

TABLE 1: OCCURRENCE OF METHANE GAS

MAP NO.	COUNTY COAL REGION (FIELD) MINE NAME (A) = active mine	MINE LOCATION (Sec.,Twp.,Rge.) (Location of entry underlined)	NAME OF MINED BED	COAL BED THICKNESS (FT)	OVERBURDEN THICKNESS (FT) (U) = Unknown	SHAFT DEPTH (FT)	COAL RANK (1)
7	Golden Quality #2	12,19S-70W		3.5	(U)		B
8	Golden Quality #3	12,13,19S-70W	Magnet	3.5	(U)		B-hv
9	Golden Quality #5(A)	2,20S-70W	Brookside	8	(U)		B
10	Griffiths	12,13,19S-70W	Ocean Wave or Magnet	3.5	(U)		B
11	Rockvale	25,36,19S-70W 19,30,31,19S-69W	Canon City	5.3-7.3	300-350 423		B
12	Rockvale #3	4,5,8,9,19S-70W	Nonac(?)Rockvale(?)	3.5-6			B-hv
	GARFIELD						
	Uinta(Grand Hogback)						
1	Black Raven	16,5S-92W		22	0-257		B-hv
2	Coryell	2,6S-91W,31,32,55S-90W	Allen	14.5	0-125		B-hv
	Uinta (Carbondale)						
3	Four Mile (A)	34,7S-89W	"A","C","D"	9.5	0-1100		B-hv
	Uinta (Grand Hogback)						
4	Harvey Gap (Old)	24,5S-92W		6	(U)		B-hv
5	Harvey Gap #2	19,5S-91W,24,5S-92W	"F"	5-11	(U)		B-hv
6	Harvey Gap #3	24,5S-92W		6	17-211		B-hv
7	IHI #3	16,5S-92W		9	281-667		B
8	McLearn	12,5S-93W,7,5S-92W		6-7	(U)		B
9	New Castle	30,31,32,5S-90W, 36-5S-91W,1-6S,91W	Wheeler	8-42	(U)		B-hv
10	New Castle-Vulcan	1,6S-91W	Allen	8-14	350-400		B-hv
11	South Canon #1	14,6S-90W	"D" Wheeler "E" Allen	18 (Ave.)	500-550		B-hv B-hv
	Uinta (Book Cliff)						
12	Stove Canon	11,12,8S-102W	Palisade	3.2-7	300-700		B-hv
	Uinta (Grand Hogback)						
13	Sunny Ridge	24,5S-92W		7	140		B-hv
14	Vulcan	1,6S-91W	Allen	14-47	350-400		B

IN COLORADO COAL MINES

DAILY PRODUCTION SHORT TONS (1st qtr., 1977)	AVERAGE METHANE EMISSION CU. FT./DAY (1st qtr., 1977)	CU.FT.GAS/TON OF COAL MINED	COAL ANALYSIS-DRY(MOIST & BTU-AS RECV'D						OCCURRENCE OF GAS IN MINES(2) (YEAR)	MAP NO.
			MOISTURE (AVE.) (As-Rec'd.)	SULFUR (AVE.) (Dry)	ASH (AVE.) (Dry)	VOLATILE MATTER (AVE.)	FIXED CARBON (AVE.) (Dry)	BTU/LB (AVE.) (As rec'd)		
Closed									G	7
Closed			8.4	1.4	9.8	42.2	47.9	11523	G	8
									G	9
Closed									GE(1937)	10
Closed									GE(1888)	11
Closed			8.8	.7	8.0	41.3	52.0	11623	G	12
Closed			7.2	.4	4.2	44.6	51.1	12295	MF(1963)	1
Closed			14.6	.3	5.7	37.9	56.3	11179	GE(1901)	2
40	None	0	5.8	.9	4.7	41.9	58.3	12684	GE(1897)	3
Closed			4.3	2.2	9.8	39.7	50.5	12401	GE(1926)	4
Closed			4.5	1.9	7.5	40.8	51.7	13086	G	5
Closed			4.1	.7	8.7	39.5	51.7	12671	G	6
Closed									GE(1954)	7
Closed									G	8
Closed			4.4	.6	8.2	41.4	50.4	12477	GE(1901)MF(1954) DE(1888)	9
Closed			4.3	.6	5.4	40.6	54.0	13229	MF(1962)	10
Closed			6.8 6.5	.4 .5	10.4 3.1	41.0 42.7	48.5 54.1	11725 12710	GE(1912) MF(1951)	11
Closed			9.3	.7	8.2	38.9	52.0	11872	G	12
Closed			5.0	.4	8.8	41.5	49.6	12258	DE(1951)DE(1952)	13
Closed									DE(1913)GE(1896) GG(1978)GE(1956)	14

TABLE 1: OCCURRENCE OF METHANE GAS

MAP NO.	COUNTY COAL REGION (FIELD) MINE NAME (A) = active mine	MINE LOCATION (Sec., Twp., Rge.) (Location of entry underlined)	NAME OF MINED BED	COAL BED THICKNESS (FT)	OVERBURDEN THICKNESS (FT) (U) = Unknown	SHAFT DEPTH (FT)	COAL RANK (1)
15	Vulcan #3	1,6S-91W			(U)		
	GUNNISON						
	Uinta (Somerset)						
1	Bear (A)	9,16,13S-90W	Juanita "C"	8	290-1440		B-hv
2	Black Beauty	1,2,10,11,12,13S-90W	"E"	10	897		B-hv
	Uinta (Crested Butte)						
3	Crested Butte	3,10,11,15,14S-86W	Crested Butte	5-25	300-400		B-hv
	Uinta (Somerset)						
4	Edwards	8,17,13S-90W	"B"	6	511-634		B-hv
			"C"	6	511-634		B-hv
	Uinta (Carbondale)						
5	Genter	20,11S-88W		3.2-4.9	148-705		A
	Uinta (Somerset)						
6	Oliver #2	10,15,13S-90W	Oliver	7	(U)		B-hv
7	Oliver #3	10,13S-90W	"E"	7	174-500		B-hv
8	Somerset (A)	8,9,13S-90W,2,10,12S-90W	Var.		-		B-hv
			B	25	1000-1500		B-hv
			C	7	-		B-hv
	HUERFANO						
	Raton (Walsenburg)						
1	Alamo	35,36,27S-68W	Walsen or Cameron	9	600-1800		B
2	Alamo #2	25,36,27S-68W	Vermijillo	10	(U)		B-hv
3	Calumet #2(see Delcarbon)	14,15,22,23,27S-67W	Walsen Robinson Cameron Lenox	4-5	250		B
4	Cameron	16,17,18,19,20,21,28S-66W	Walsen & Cameron	7	165-500	170	B
5	Gordon	22,23,26,27,27S-67W	Various		(U)		B-hv
			Cameron	4			B-hv
6	Hezron	7,12,13,14,18,29S-66W	Robinson	4			B
7	Maitland	36,27S-67W 1,6,31,27S-66W	L. Robinson	3.5	165-200		B-hv
8	Midway	19,29S-65W		4.5-5.6	(U)		B
9	Mutual	18,28S-66W	Walsen	7.1	400		B

IN COLORADO COAL MINES

DAILY PRODUCTION SHORT TONS (1st qtr., 1977)	AVERAGE METHANE EMISSION CU.FT./DAY (1st quarter, 1977)	CU.FT.GAS/TON OF COAL MINED	COAL ANALYSIS-DRY(MOIST & BTU-AS RECV'D)						OCCURRENCE OF GAS IN MINES (2) (YEAR)	MAP NO.
			MOISTURE (AVE.) (As-Rec'd.)	SULFUR (AVE.) (Dry)	ASH (AVE.) (Dry)	VOLATILE MATTER (AVE.)	FIXED CARBON (AVE.) (Dry)	BTU/LB (AVE.) (As rec'd)		
Closed									GE(1918)GE(1956)	15
600	259,000	431.6	5.7	.5	6.0	40.8	53.1	12812	G	1
Closed			6.2	.6	4.2	40.7	54.9	12940	G	2
Closed			3.5	.4	5.4	38.9	55.6	13308	GE or DE(1883), GE(1884)	3
Closed			5.0	.4	8.4	40.2	51.2	12570	G	4
			6.1	.4	6.1	40.4	51.4	12732	G	
Closed									GE(1925)	5
Closed			6.1	.5	6.8	40.5	52.6	12573	G	6
Closed			6.5	.5	4.4	41.1	54.3	12896	G	7
4500	1,692,000	376	6.4	.7	6.1	39.5	54.4	12755	G	8
			5.4	.5	11.5	38.8	51.0	12412	G	
			5.6	.6	7.4	39.4	53.6	12737	G	
Closed									GE(1924)	1
Closed			7.1	.9	11.5	38.7	49.6	11393	GE(1942,1943)	2
Closed			6.2	.8	10.2	39.5	49.7	11743	G	3
Closed									GE(1918)	4
Closed			5.9	.6	12.1	39.7	46.9	11373	G and	5
			6.1	.8	11.4	39.9	48.9	11765	GE(1925)	
Closed									GE(1918)	6
Closed			6.2	.6	14.0	37.6	48.3	11245	GE(1906)	7
Closed									GE(1907)	8
Closed									GE(1915)	9

TABLE 1: OCCURRENCE OF METHANE GAS

MAP NO.	COUNTY COAL REGION (FIELD) MINE NAME (A) = active mine	MINE LOCATION (Sec., Twp., Rge.) (Location of entry underlined)	NAME OF MINED BED	COAL BED THICKNESS	OVERBURDEN THICKNESS (FT) (U) - Unknown	SHAFT DEPTH (FT)	COAL RANK (1)
10	Oakdale	9,10,15,16,29S-69W	Mammoth	4-13	100-500		B
11	Pictou	6,7,28S-66W 1,2,28S-67W 31,27S-66W 36,27S-67W	Walsen Cameron Robinson	12	(U)		B
12	Solar	19,28S-66W		4.5	(U)		B
	JEFFERSON						
	Denver(Boulder-Weld)						
1	Leyden #3	21,22,26,27,28,34,2S-70W	Leyden	7.7	700-792	787	SB
2	Leyden	26,27,2S-70W		9		792	SB
	LA PLATA						
	San Juan(Durango)						
1	Burnwell #1	29,35N-11W		6.5	70-110		B-hv
	Burnwell #2	29,32,35N-11W		6.5	70-110		B-hv
3	Champion	31,34½N-9W 31-35N-9W		3.5-4	180		B
4	Hesperus(old) #1 & 2	14,15,22,23,35N-11W		5-6.7	100-200		B-hv
5	King Coal (A)	31,32,35N-11W		6	(U)		B-hv
	LAS ANIMAS						
	Raton(Trinidad)						
1	Allen (A)	21,22,23,26,27,28,33S-68W	Allen or Circula	5	100-2500+		B-hv
2	Bear Canon #3	2,11,12,32S-65W	Cass ?	5	100-200		B-hv
3	Berwind (4 entries)	30,31,31S-64W 6,32S-64W 1-32S-65W 25,36,31S-65W	L. Ludlow or Berwind	5-6	(U)		B-hv
4	Boncarbo	31,32,36,32S-65W	Primero	5.2	150-500		B-hv
5	Bowen	24,32S-64W		7-8	(U)		
6	Brodhead #9	17,18,19,20,30S-65W	Brodhead #4	4	700		B
7	Cokedale #1 & 2	30,31,33S-64W 25,26,33S-65W	Cokedale	6-7	40-60		B
8	Cuatro	31,32,34S-64W		4	(U)		B

IN COLORADO COAL MINES

DAILY PRODUCTION SHORT TONS (1st qtr., 1977)	AVERAGE METHANE EMISSION CU.FT./DAY (1st quarter, 1977)	CU.FT.GAS/TON OF COAL MINED	COAL ANALYSIS-DRY(MOIST & BTU-AS RECV'D) MOISTURE (AVE.) (Ad-Rec'd.)	SULFUR (AVE.) (Dry)	ASH (AVE.) (Dry)	VOLATILE MATTER (AVE.)	FIXED CARBON (AVE.) (Dry)	BTU/LB (AVE.) (As rec'd)	OCCURRENCE OF GAS IN MINES(2) (YEAR)	MAP NO.
Closed									GE(1908),GE(1919)	10
Closed									GE(1902)	11
Closed									GE(1909)	12
Closed									G	1
Closed			19.5	.4	5.7	40.1	54.0	9724	MF(1910)	2
Closed			5.0	1.1	5.2	40.4	54.4	13250	GE(1966)	1
Closed			3.9	.6	6.2	39.6	54.0	13316	G	2
Closed									GE(1908)	3
Closed			6.4	.5	10.0	39.2	50.6	12230	MF(1953)	4
			4.6	1.0	6.3	40.5	53.1	13155	G	5
2,596 (4th qtr. 1976)	428,000	164.8	3.9	.5	21.4	34.4	44.1	11258	G GE(1956)	1
Closed									GE(1926)	2
Closed			2.5	.6	15.4	32.7	51.8	12103	GE(1917)	3
Closed			4.4	.6	14.4	33.1	52.4	12237	GE(1947)	4
									DE(1902)	5
Closed									GE(1902) MF(1907)	6
Closed									DE(1911)	7
Closed									GE(1906)	8

TABLE 1: OCCURRENCE OF METHANE GAS

MAP NO.	COUNTY COAL REGION (FIELD) MINE NAME (A) - active mine	MINE LOCATION (Sec., Twp., Rge.) (Location of entry underlined)	NAME OF MINED BED	COAL BED THICKNESS	OVERBURDEN THICKNESS (FT) (U) = Unknown	SHAFT DEPTH (FT)	COAL RANK (1)
9	Daisy #1 & 2	32-30S-64W 5,31S-65W		3	(U)		B-hv
10	Delagua	3,4,9,10,11,15,16,21,22,31S-65W	Delagua	5.8-7.8	300-700		B-hv
11	Empire	28,29,30,33,34,30S-65W	Walsen	5.6-6	600		B
12	Engle	28,29,30,31,32,36,33S-63W 31,32,33S-65W	Engle	6.5-8	(U)		B-hv
13	Frederick	5,6,7,8,9,17,34S-65W	Frederick	3.5-5.6	80-120		B-hv
14	Greenville	30,31S-64W	Berwind	6-7	(U)		B
15	Hastings #3	13,31S-65W		7	(U)		B
16	Hastings #4	13,23,24,31S-65W	Berwind	8	800		B
17	Morely	31,32,34S-63W 5,6,35S-63W 36-34S-64W 1-35S-64W	Morely	4-10	250-1000		B-hv
18	Piedmont	34-33S-64W	Lower	3.7	(U)		B
19	Primero	13,14,23,24,25,26,27,33S-66W	Primero	6.5-7.2	50-850		B
20	Rapson #1	4,9,30S-65W	L. Robinson	5	(U)		B-hv
21	Rapson #2	9,30S-65W	Walsen	5	(U)		B-hv
22	Royal	20,21,28,29,30S-65W	Walsen Peerless	6	270-1000		B
23	Sopris #1	3,4,5,9,10,34S-64W 32,33,34,33S-64W	Cameron	6	(U)		B
24	Southwestern	9,16,30S-65W	Walsen	4	(U)		B-hv
25	Starkville (9 mines)	4,5,6,34S-63W 31,32,33,34S-63W 1-34S-64W 36-33S-64W	Engle- Starkville	4-6	150-1000		B-hv
26	Tabasco	25,26,35,36,31S-65W	Hastings	5.3-8.6	1000		B Natl. Coke
27	Tercio	21,22,34S-68W	#2 & #3	#2)6.7 #3)3.6	(U)		B
28	Toller	35,36,31S-65W 1,2,11,32S-65W	Berwind	5-7	350-400 1000	350	B
29	Victor #3	13,31S-65W		7	(U)		B

IN COLORADO COAL MINES

DAILY PRODUCTION SHORT TONS (1st qtr., 1977)	AVERAGE METHANE EMISSION CU.FT./DAY (1st qtr., 1977)	CU.FT.GAS/TON OF COAL MINED	COAL ANALYSIS-DRY(MOIST & BTU-AS RECV'D) MOISTURE (AVE.) (As-rec'd.)	SULFER (AVE.) (Dry)	ASH (AVE.) (Dry)	VOLATILE MATTER (AVE.)	FIXED CARBON (AVE.) (Dry)	BTU/LB (AVE.) (As-rec'd)	OCCURRENCE OF GAS IN MINES (2) (YEAR)	MAP NO.
Closed			2.6	.6	14.0	36.2	49.7	12290	GE(1940)	9
Closed			2.4	.7	15.9	36.2	47.8	12110	GE(1910)	10
Closed									GE(1919)	11
Closed			2.8	.6	13.7	30.5	55.6	12545	GE(1906) MF(1907)	12
Closed			1.8	.6	16.4	30.3	53.2	12518	G	13
Closed									DE	14
Closed									G GE(1912)	15
Closed									G GE(1917)	16
Closed			1.8	.8	15.4	31.6	52.9	12610	G. DE(1909)	17
Closed									GE(1912)	18
Closed									GE(1907) 1910)	19
Closed			2.7	.6	4.8	37.1	52.1	12772	G	20
Closed			2.5	.6	13.2	36.2	50.5	12517	G	21
Closed									GE(1914) MF(1911)	22
Closed									GE(1895 1922)	23
Closed			2.8	.6	11.9	33.4	54.6	12656	GE(1923)	24
Closed			1.9	.7	18.3	30.1	51.4	12288	GE(1888) MF(1910-1911) GE or DE (1910)	
Closed									GE(1906)	26
Closed									DE(1904)	27
Closed									GE(1909) GS(1913)	28
Closed									DE(1910) MF(1910)	29

TABLE 1: OCCURRENCE OF METHANE GAS

MAP NO.	COUNTY COAL REGION (FIELD) MINE NAME (A) = active mine	MINE LOCATION (Sec., Twp., Rge.) (Location of entry underlined)	NAME OF MINED BED	COAL BED THICKNESS (FT)	OVERBURDEN THICKNESS (FT) (U) = Unknown	SHAFT DEPTH (FT)	COAL RANK(1)
	MESA						
	Uinta-Piceance (Book Cliffs)						
1	Cameo (A)	27,28,33,34,10S-98W	Cameo	6-9.5	2000		B-hv
	(Grand Mesa)						
2	Grandview	11,11S-98W		4-5			B-hv
	(Book Cliffs)						
3	McGinley (A)	5,9S-100W	Cameo	11	500		B-hv
	(Grand Mesa)						
4	Midwest	10,11,11S-98W	Palisade	4.8	100		B
	(Book Cliffs)						
5	Palisade	3,4,5,11S-98W	Palisade	3-4	(U)		B-hv
	MOFFAT						
	Uinta-Piceance (Danforth Hills)						
1	Red Wing	3A,4,35,4N-93W 2,3-3N-93W	Collum	23	100-1000		B-hv
	(Yampa)						
2	Wisconsin	6-6N-93W 31-7N-98W		8.3	(U)		B
	PARK						
	South Park (South Park)						
1	Como	2,11,9S-76W		7	(U)		SB
2	Como #5	2,9S-76W		4-6	(U)		SB
	PITKIN						
	Uinta-Piceance (Carbondale)						
1	Bear Creek (A)	21,10S-89W	Coal Basin "B"	7	200-1500		B-mv
2	Coal Basin (A)	5,8,10S-89W	Coal Basin "B" and "C"	6.9-8	150-600		B-mv
3	Dutch Creek #1 (A)	17,10S-89W	Coal Basin "B"	7	0-2100		B-mv
4	Dutch Creek #2 (A)	17,10S-89W	Dutch Creek	7	1370-1800		B-mv

IN COLORADO COAL MINES

DAILY PRODUCTION SHORT TONS (1st qtr., 1977)	AVERAGE METHANE EMISSION CU.FT./DAY (1st qtr., 1977)	CU.FT.GAS/TON OF COAL MINED	COAL ANALYSIS-DRY(MOIST & BTU-AS REC'D) MOISTURE (AVE.) (As-rec'd)	SULFER (AVE.) (Dry)	ASH (AVER.) (Dry)	VOLATILE MATTER (AVE.)	FIXED CARBON (AVE.) (Dry)	BTU/LB (AVE.) (As-rec'd)	OCCURRENCE OF GAS IN MINES (2) (YEAR)	MAP NO.
			7.5	.6	11.3	38.0	50.6	11659	G	1
Closed									GE(1908)	2
			8.5	.6	8.9	38.7	54.1	11723	G	3
Closed									GE(1923)	4
Closed			7.7	.8	8.9	40.0	51.0	12037	MF(1900)	5
Closed			11.4	.4	3.7	42.6	53.5	11646	MF(1974)	1
Closed									MF(1944)	2
Closed									G GE(1885)	1
Closed									GE(1890) DE(1893)	2
480	885,000	492 1843.7	4.0	.5	4.6	25.3	70.1	14680	G	1
431	1,750,000	1821 4060.3	4.2	.6	9.6	23.0	67.3	13590	G	2
642	2,235,000	2631 3481.3	3.9	.6	8.2	22.9	68.8	13940	GE(1965) DE(1957)	3
1008	1,489,000	867.7 1477.1	3.8	.6	4.2	21.4	74.1		G	4

TABLE 1: OCCURRENCE OF METHANE GAS

MAP NO.	COUNTY COAL REGION (FIELD) MINE NAME (A) = active mine	MINE LOCATION (Sec., Twp., Rge.) (Location of entry underlined)	NAME OF MINED BED	COAL BED THICKNESS (FT)	OVERBURDEN THICKNESS (FT) (U = Unknown)	SHAFT DEPTH (FT)	COAL RANK(1)
5	L. S. Wood(A)	8,10S-89W	Coal Basin "B"	7	0-1650		B-mv
6	Placita (old)	6,11S-88W		3.4	200?		B
7	Spring Gulch	15,22,23,26,27-8S-89W	Anderson Allen	4.5-6 8-11.5	0-1000		B
8	Thompson Creek #1 (A)	34,35,8S-89W	"A" "B"	8 8	300+ 300+		B-hv B-hv
9	Thompson Creek #2 (A)	34,35,8S-89W	"A" & "B"	7	80-100		B-hv
10	Thompson Creek #3 (A)	34, 8S-89W	Sunshine	9	(U)		B-hv
	RIO BLANCO						
	Unita-Piceance (Lower White) (River)						
1	White River	2,10,11,2N-101W		7.8	(U)		B-hv
	ROUTT						
	Green River (Yampa)						
1	Apex #2(A)	22,4N-86W	Pinnacle	4.5	(U)		B-hv
2	Babson	4,5N-88W		10.5	(U)		B-hv
3	Oak Hills #2	27,8N-87W	Pinnacle	10-12	(U)		B-hv
4	Wadge #1 & #2	9,10,15,6N-87W	Wadge	8.5	#1)400-500 #2)200-400		B-hv
	WELD						
	Denver (Boulder-Weld)						
1	Boulder Valley (old)	18,1N-68W		6.6-10.3	316		SB
2	Boulder Valley (new)	17,20,21,1N-68W		10	350		SB
3	Boulder Valley #3	1,1N-68W		6.5	245		SB

IN COLORADO COAL MINES

DAILY PRODUCTION SHORT TONS (1st qtr., 1977)	AVERAGE METHANE EMISSION CU.FT./DAY (1st qtr., 1977)	CU.FT.GAS/TON OF COAL MINED	MOISTURE (AVE.) (As-rec'd)	SULFER (AVE.) (Dry)	ASH (AVE.) (Dry)	VOLATILE MATTER (AVE.)	FIXED CARBON (AVE.) (Dry)	BTU/LB (AVE.) (As-rec'd)	OCCURRENCE OF GAS IN MINES[2] (YEAR)	MAP NO.
1800	1,867,000	2087 1037.2	3.0	.8	7.8	22.6	69.6	14521	G	5
Closed									GE(1923)	6
Closed									DE(1901)	7
113	18,000		3.5	1.2	14.1	30.3	55.6	12830	GE(1956)	8
		159.2	2.6	1.0	8.9	30.8	60.3	13740		
Closed			3.1	1.1	12.3	29.5	58.2	13220	G	9
?	None		2.9	.7	7.8	33.6	58.5	13745	G	10
Closed			11.0	.4	7.9	39.3	53.0	10682	G	1
60(1974)	11,400(1974)	190	9.1	.5	5.4	41.2	53.2	12008	GE or DE (1943)	1
Closed			14.1	.4	6.4	37.6	55.9	10864	MF(1965)	2
Closed			8.1	.6	6.5	40.7	52.6	12031	DE(1921)	3
Closed			9.6	.5	7.8	40.0	52.1	11517	GE(1942)	4
Closed									G	1
Closed									G	2
Closed			23.5	.5	6.3	38.9	54.7	9447	G	3

TABLE 1: OCCURRENCE OF METHANE GAS

MAP NO.	COUNTY COAL REGION (FIELD) MINE NAME (A) = active mine	MINE LOCATION (Sec., Twp., Rge.) (Location of entry underlined)	NAME OF MINED BED	COAL BED THICKNESS (FT)	OVERBURDEN THICKNESS (FT) (U = Unknown)	SHAFT DEPTH (FT)	COAL RANK(1)
4	Eagle (A)	14,15,22,1N-68W	Laramie #3	9		370	SB
5	Imperial	10,11,1N-68W		10.5	270	2790	SB
6	Lincoln	13,24,1N-68W		8-10		425	SB
7	Parksdale	6-1S-68W 31-1N-68W		7-10			SB
8	Russell	20,29,2N-67W		6	300	220	SB
9	Sterling	31,32,2N-67W 6,7-1N-67W		7.9	340-360	358	SB
10	Washington (new)	22,23,26,27,28,1N-68W		8-12		430	SB
	ADDENDUM						
None	Delta County Uinta Region, Grand Mesa Field Orchard Valley Mine	24,13S,92W	"B"	27' avg.	450'-1800'		Bit
	Gunnison County Uinta Region, Somerset Field Hawk's Nest West	12,13S,90W	"E"	8-9'	1600'-2000'		hvB
	Hawk's Nest East	11,13S,90W	"E"	7-9'	1600' max		hvB
	Uinta Region, Crested Butte Field O.C. Mine #2	16,15S,86W	"C" Kubler	5.5-6.0'	1800'-2000'		Bit
	Mesa County Uinta Region, Book Cliffs Field C.M.C. Mine	34,10S,98W	Cameo "B"	7'	<1800'		hvB

(1) A = anthracite
B = bituminous
SB = subbituminous

hv = high-volatile
mv = medium-volatile
lv = low-volatile

(2) G = gassy mine
GE = gas explosion
GS = gas suffocation
DE = dust explosion (methane related?)
MF = mine fire

Note: Numerous minor mine explosions are not listed.

IN COLORADO COAL MINES

DAILY PRODUCTION SHORT TONS (1st qtr., 1977)	AVERAGE METHANE EMISSION CU.FT./DAY (1st qtr., 1977)	CU.FT.GAS/TON OF COAL MINED	MOISTURE (AVE.) (As-rec'd)	SULFER (AVE.) (Dry)	ASH (AVE. (Dry)	VOLATILE MATTER (AVE.)	FIXED CARBON (AVE. (DRY)	BTU/LB (AVE.) (As-rec'd)	OCCURRENCE OF GAS IN MINES (2) (YEAR)	MAP NO.
250(1st qtr.,1976)	7,000	28,4.6	21.3	.4	6.0	38.9	55.3	9840	G	4
Closed			21.7	.4	6.0	38.7	55.0	9761	G	5
			24.3	.4	7.3	37.9	54.7	9330	G	6
Closed									GS(1915)	7
Closed			23.2	.6	6.8	38.3	54.7	9482	MF(1947)	8
Closed			24.5	.5	6.0	36.4	55.1	9313	G	9
Closed			21.5	.4	6.3	38.8	54.8	9636	GE(1946)	10
										None
600	None	0	10-11	.4	3.4			12,000		
800	425,000	531	4.4-7.1	.3-.5	3.2-9.1			12,400-13,400		
150	29,000	193	Unknown	.3-.5	5-7			12,500		
20	None	0	9.5-10.1	.3-.6	4.3-6.0			11,840		
300	24,00	80	5-6	.4-.6	7-11			11,990-13,011		

TABLE 2

DESORPTION DATA FOR METHANE GAS FROM COLORADO COAL CORES

TEST NO.	COAL REGION / FORMATION / COAL FIELD	GEOLOGIC FORMATION AGE	COAL BED NAME	DATE SAMPLED	SURFACE ELEVATION	DEPTH TO BED (FT.)	BED THICKNESS (FT.)	SAMPLE WEIGHT (GRAMS)	TEST PERIOD (DAYS)	GAS DESORBED (CM^3)
	SAN JUAN RIVER REGION									
1	Durango Field	Menefee Fm (U. Cret.)	unknown	2/3/76	7800±	295	9.0±	1336	35	105[1,2]
2	Durango Field	Menefee Fm (U. Cret.)	unknown	2/4/76	7520	310	7.5	1318	34	91[2]
	RATON MESA REGION									
3	Walsenburg Field	Vermejo Fm (U. Cret.)	Prior(above Walsen)	6/9/76	6440	111	4.0	1049	28	51[1]
4	Walsenburg Field	Vermejo Fm (U. Cret.)	Walsen(below Prior)	6/10/76	6440	155	6.0	1211	27	82[1]
	GREEN RIVER REGION									
5	Yampa Field	Williams Fork Fm (U. Cret.)	Wadge	8/23/76	7000	1283	11.5	1560	10	0[2]
6	Yampa Field	Williams Fork Fm (U. Cret.)	Wadge	8/26/76	6860±	1393	11.0	1126	13	49[1,2]
7	Yampa Field	Williams Fork Fm (U. Cret.)	U.Wolf Creek	9/18/76	6810	488	1.3	852	15	32[2]
8	Yampa Field	Williams Fork Fm (U. Cret.)	Wadge	9/19/76	6810	335	8.5	1233	16	165[1]
9	Yampa Field	Williams Fork Fm (U. Cret.)	Upper "A" Wolf Creek	10/5/76	6800?	1104	4.5	1038	9	112[1]
10	Yampa Field	Williams Fork Fm (U. Cret.)	Lower "A" & "B" Wolf Creek	10/6/76	6800?	1123	9.7	1442	8	118[2]
	UINTA REGION									
11	Danforth Hills Field	Williams Fork Fm (U. Cret.)	unknown	7/9/77	7049	2216	15	329	23	177[1]
12	Danforth Hills Field	Williams Fork Fm (U. Cret.)	unknown	7/9/77	7049	2243	4	486	23	153[1]
13	Danforth Hills Field	Williams Fork Fm (U. Cret.)	unknown	7/9/77	7140	2122	12	679	23	234[1]
14	Danforth Hills Field	Williams Fork Fm (U. Cret.)	unknown	8/4/77	7029	2106	8	725	17	74[2]
15	Danforth Hills Field	Williams Fork Fm (U. Cret.)	"J-J"	9/24/77	7640	48.7	10.8	863	23	1
16	Danforth Hills Field	Williams Fork Fm (U. Cret.)	"J-J"	9/28/77	7200	502.6	12	797	23	0
17	Grand Mesa Field	Williams Fork Fm (U. Cret.)	"D"	6/30/77	7720	504	5.8	773	30	116[2]
18	Grand Mesa Field	Williams Fork Fm (U. Cret.)	unknown	9/20/77	6750	706.7	7.6	238	32	1018
19	Grand Mesa Field	Williams Fork Fm (U. Cret.)	unknown	9/20/77	6750	706.7	7.6	396	32	225

Footnotes:

1 Stopped test due to low gas emission rate.
2 Residual gas calculated with a non-useable formula.
3 New formula used to calculate "lost" gas when a cylinder went on a vacuum.
4 Cylinder went on vacuum when moved from coring site to Denver.

DESORPTION DATA FOR METHANE GAS IN COAL (CONTINUED)

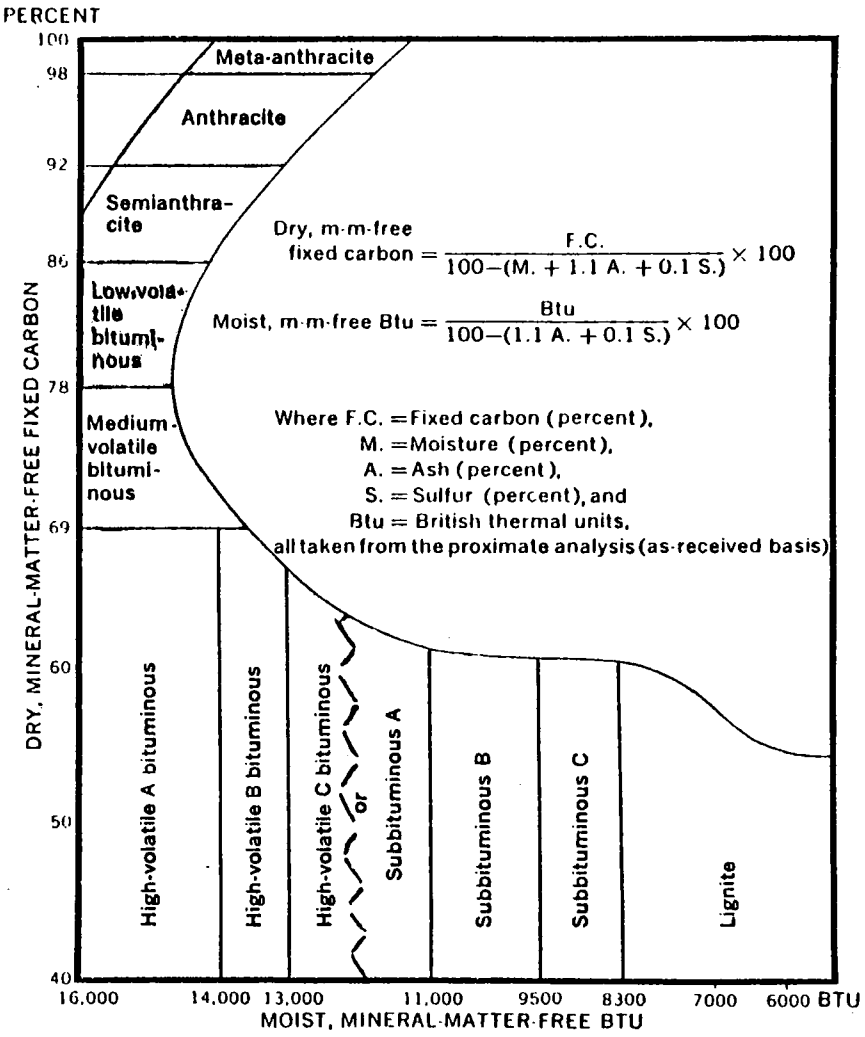
LOST GAS CM^3	CALCULATED RESIDUAL + DESORBED + LOST GAS (CM^3)	FT^3 METHANE/TON COAL (CM^3/G)	CYLINDER WENT ON VACUUM[4]	ANALYSIS (as received-basis) ULTIMATE CARBON %	VOLATILE MATTER %	ASH %	MOISTURE %	SULFUR %	HEATING VALUE (BTU/LB)	APPARENT RANK OF COAL
40	225[2]	5.3 (.17)	Yes	71.0	34.7	9.7	3.4	.7		
145	421[2]	10.2 (.32)	Yes	65.2	32.0	17.2	3.1	.7		
75	984[2&3]	29.7 (.07)	Yes	64.4	37.0	11.1	7.5	.7	12971	hvCBit.
241	1313[2&3]	34.6 (1.08)	Yes	63.2	36.4	13.0	6.8	.6	12943	hvCBit.
Not calculated	Not calculated	Not calculated	Yes	66.9	34.2	7.5	8.2	.5	12917	hvCBit.
45	541[2&3]	15.3 (.48)	Yes	67.4	35.6	6.4	8.2	.4	12922	hvCBit.
Not calculated	Not calculated	Not calculated	Yes	66.6	35.2	5.1	9.6	.6	12465	hvCBit.
62	302[2]	7.7 (.24)	No	65.1	33.9	7.8	8.8	.6	12590	hvCBit.
Not calculated	Not calculated	Not calculated	Yes	72.7	36.0	5.7	4.5	.5	13902	hvBBit.
Not calculated	Not calculated	Not calculated	Yes	composited with No. 9						
0	177	16 (.50)	Yes	confidential						
460 (?)	613	41.6 (1.31)	Yes							
284 (?)	518	31.4 (.98)	Yes							
0	74	3.3 (.10)	Yes							
Not calculated	0	0 (0)	Yes	61.8	33.2	3.3	16.1	.4	10997	hvCBit
Not calculated	0	0 (0)	Yes	63.8	32.4	4.1	14.4	.3	11368	hvCBit
Not calculated	149	6.4 (0.19)	Yes	67.9	37.8	3.7	10.8	.4	12337	hvCBit
320	1338	179.2 (5.62)	Yes	59.3	30.9	11.7	11.8	.7	12007	hvCBit
100	325	25.6 (.82)	Yes	composite with #18						

TABLE 3: DATA FROM EXAMINED COAL MINES

MINE NAME	CLEAT ORIENTATION	MINING PROBLEMS	MOISTURE %	VOLATILE MATTER %	FIXED CARBON %	ASH %	SULFUR %	HEATING VALUE BTU/LB	FSI
Bear Mine	Cleat: Strike-Face N46°E Dip-approx. 90° Spacing - varied Well developed bedding - No info.	Mining toward west. East side closed due to .3-1.0 (1.5%) methane Fault near east side of workings Not exposed	4.5-7.0	39.6-42.4	52.1-55.4	2.8-8.9	.4-1.0	12,170-13,430	1-2.5
Hawk's Nest #3	Cleat-face N50°E Dip 90° Spacing .04'-1.0' Well developed bedding - no info.	No problems mentioned in field notes.	4.4-7.1	38.7-42.5	51.5-56.6	3.5-6.3	.4-.6	12,400-13,400	1.0-3.0
Somerset Mine	Cleat: Strike Face N29-49°E Dip 72°-86°SE Strike-Butt-N45°-55°W Dip 52-55° SW Bedding-Strike NW Dip 6°NE	"B" Seam has Lt. gray SS dike (spars) occuring occasionally coming up from the floor and sometimes extending through the seam to the roof rock contact.	4.5-7.1	38.2-40.4	48.1-54.3	7.9-12.0	.4-.6	12,070-12,990	1.5-3.0
CMC Mine	Cleat-Strike-Face N37°E Dip 90° Spacing-varied well developed Strike-Face-N53°W Dip 90° Moderately well developed Bedding N65°W Dip N25°E	No problems mentioned in field notes.	5.0-6.0	35.4	47.3	7-11	.4-.6	11,990-13,010	1.0
Dutch Creek #1	No cleat orientation Bedding-Strike N-NE Dip 13°NW	High methane content of coal	4.5-7.0	39.6-41.9	51.5-54.0	3.2-7.2	.4-.6	13,980-15,200	2.5-9.

Analyses obtained from published analyses from U. S. Bureau of Mines (1973)

Table 4. Classification of coals by rank



BASIS OF RANK CLASSIFICATION OF COALS IN THE UNITED STATES, AND THE FORMULAE USED IN MAKING APPROXIMATE RANK DETERMINATIONS

Determinations based on the above cannot be considered final or even adequate for any but the most general application. For further information, see the Standard Specifications for Classification of Coals by Rank of the American Society for Testing Materials, A.S.T.M. designation D388-38.

(from J. Trumbull, 1960, Coal fields of the United States, Sheet 1, U. S. Geological Survey)

DEPARTMENT OF NATURAL RESOURCES
COLORADO GEOLOGICAL SURVEY
JOHN W. ROLD, DIRECTOR

CGS OPEN-FILE 78-3

STATE OF COLORADO "DATA ACCUMULATION ON THE METHANE POTENTIAL OF THE COAL BEDS OF COLORADO" FINAL REPORT PLATE 1

METHANE IN COLORADO COAL MINES

COMPILED BY H.B. FENDER AND D.C. JONES, 1976 & 1977

GREEN RIVER REGION

UINTA REGION

NORTH PARK REGION

DENVER REGION

RATON MESA REGION

SAN JUAN RIVER REGION

NORTH PARK FIELD

MIDDLE PARK FIELD

YAMPA FIELD

DANFORTH HILLS FIELD

LOWER WHITE RIVER FIELD

GRAND HOGBACK FIELD

BOULDER-WELD FIELD

BOOK CLIFFS FIELD

CARBONDALE FIELD

SOUTH PARK FIELD

CRESTED BUTTE FIELD

SOMERSET FIELD

GRAND MESA FIELD

COLORADO SPRINGS FIELD

CANON CITY FIELD

TONGUE MESA FIELD

NUCLA-NATURITA FIELD

PAGOSA SPRINGS FIELD

DURANGO FIELD

WALSENBURG FIELD

TRINIDAD FIELD

EXPLANATION

SURFACE MINES

- ACTIVE OR LICENSED AS OF 5/1/77
- ABANDONED

UNDERGROUND MINES

- ACTIVE OR LICENSED AS OF 5/1/77
- ABANDONED

APPROXIMATE OUTLINE OF COAL-BEARING REGION

- GASSY MINE
- GAS EXPLOSION
- DUST EXPLOSION (METHANE-RELATED?)
- MINE FIRE AND/OR GAS SUFFOCATION (SEE TABLE 1 FOR DETAILS)
- NUMBERS CORRESPOND TO NUMBERS ON TABLE 1

29.8 % VOLATILE MATTER (AVERAGE) (DRY SAMPLE--ONE OR MORE BEDS)
R RUN OF MINE
W WASHED

NOTE: MINE SYMBOLS IN AREAS OF CLOSELY SPACED MINES MAY REPRESENT MORE THAN ONE MINE OPENING.

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FUNDED BY U.S. BUREAU OF MINES GRANT NO. G-0166008

SCALE 1:500,000

DEPARTMENT OF NATURAL RESOURCES
COLORADO GEOLOGICAL SURVEY
JOHN W. ROLD, DIRECTOR

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PLATE 2

NORTH - SOUTH STRATIGRAPHIC CROSS SECTION

CORRELATION OF MESAVERDE GROUP COAL BEDS

EASTERN PICEANCE CREEK BASIN

GARFIELD, MESA, AND GUNNISON COUNTIES, COLORADO

JULY 1976
REVISED JULY 1977

VERTICAL SCALE: 1" = 200' NO HORIZONTAL SCALE

BY H.B. FENDER

COLORADO GEOLOGICAL SURVEY
SUPPORTED BY U.S. BUREAU OF MINES GRANT G-0166008

A
NORTH

A'
SOUTH

1
MOUNTAIN STATES
#1 BAUTEN
NE NE 22-7S-91W

2
SUN OIL COMPANY
#8 Divide Creek Unit
SE NE 14-8S-91W
Log starts in Kmv

3
THE CALIFORNIA COMPANY
#1 Hurd Gov't
SE NE 36-8S-91W
Kmv at Surface

4
CLARK OIL & REFINING CO.
#1 Federal
NE NW 18-9S-90W
Log starts in Kmv

5
SUNRAY D-X
#1 So. Wolf Creek Unit
NE SE 34-9S-90W
Top Kmv

LOCATION MAP

PROBABLE COAL BED
(1 SAMPLE DATA EXAMINED)

VOLCANIC INTRUSIVE BODY

6
WESTRANI PETROLEUM INC.
#24-1 Federal
NE SW SW 24-10S-90W
Hole starts in Wasatch

7
DELHI-TAYLOR OIL
#1 Pasco Spatafore
NE NE 23-11S-90W
Starts in Wasatch
Top Kmv

8
PETRO-LEWIS CORP.
#31 Hotchkiss Ranch
NE NE NW 11-12S-90W
Starts in Kmv

Top Paonia
Placita-Sunshine
Top Bowie
Dutch Creek
Pocahontas (D)
Wheeler Zone
Coal Basin A+B
Top Rollins
Top Mancos Tongue (silt)
Top Mancos Tongue (shale)
(DATUM) Top Cozzette
Upper Mesaverde Coals
Lower Paonia Coal Group
Lower Bowie Coal Group
Top Bowie
Hawkinsett (R)
See Note Below Oliver (D)
Pocahontas (D)
Wheeler (C)
Coal Basin A+B
Bear Canyon Sandstone B
Rollins SS.
Top Mancos Tongue (silt)
Top Mancos Tongue (shale)
Top Cozzette (Datum)

4± mi | 3± mi | 2½± mi | 4½± mi | 4½± mi | 8± mi | 3½± mi

* NOMENCLATURE AFTER COLLINS, B.A., 1976, COAL DEPOSITS OF THE CARBONDALE, GRAND HOGBACK, AND SOUTHERN DANFORTH HILLS COAL FIELDS, EASTERN PICEANCE BASIN, COLORADO: COLORADO SCHOOL OF MINES QUARTERLY, VOL. 71, NO. 1, 138 P.

Note
Correlation of coal beds is uncertain and tentative. Bed names are local names taken from literature. Mostly from Johnson, V.A., 1948, Geology of the Paonia coal field, Delta and Gunnison Counties, Colo.: U.S.G.S. Prel. Map and Collins, B.A. (See title in lower left corner).

H.B. FENDER

"DATA ACCUMULATION ON THE METHANE POTENTIAL OF THE COAL BEDS OF COLORADO" FINAL REPORT

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EASTERN PICEANCE CREEK BASIN

GUNNISON, DELTA, and MESA COUNTIES, COLORADO
July 1977

Vertical Scale: 1" = 200'   No Horizontal Scale

by H. B. FENDER
COLORADO GEOLOGICAL SURVEY

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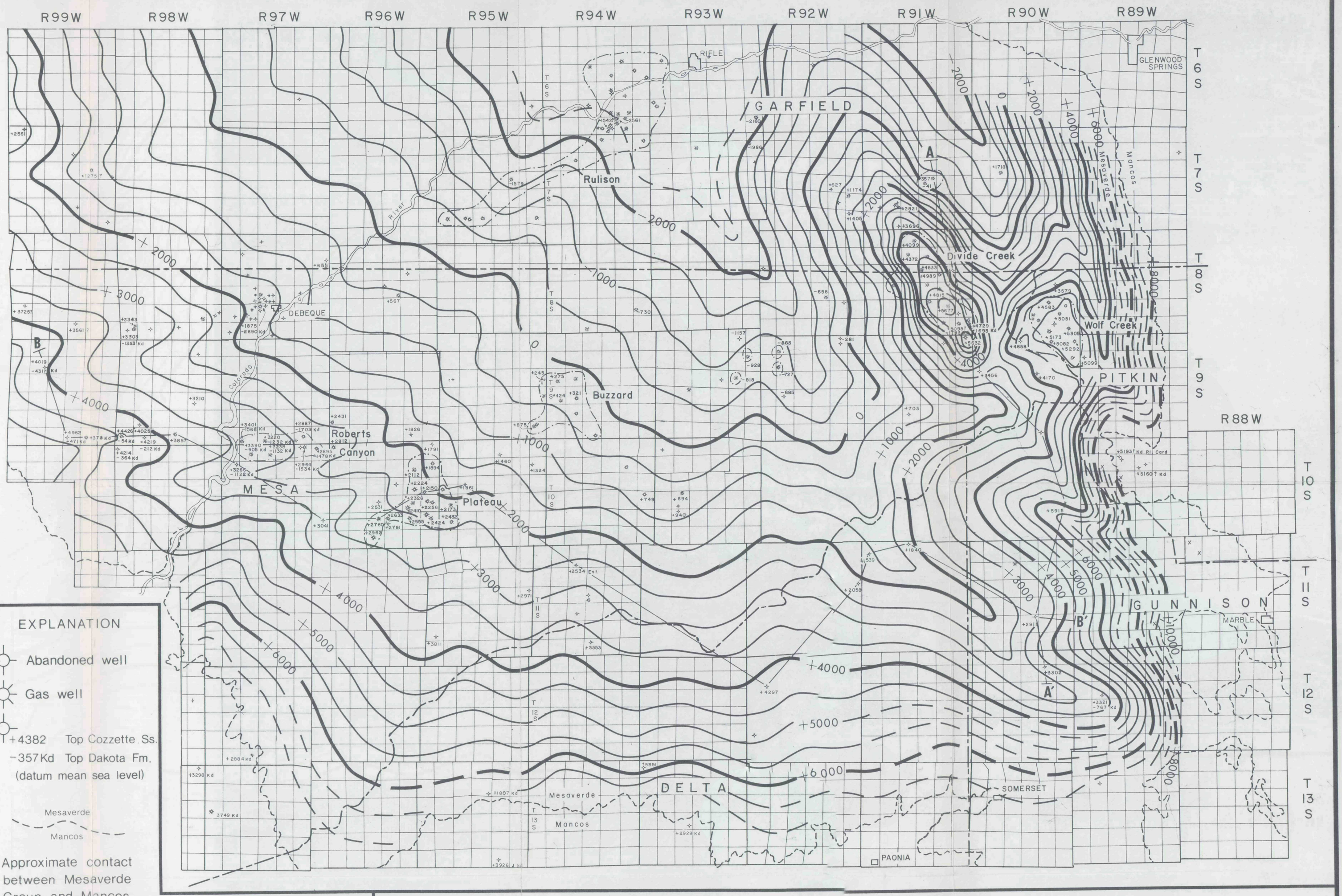
DEPARTMENT OF NATURAL RESOURCES
COLORADO GEOLOGICAL SURVEY
JOHN W. ROLD, DIRECTOR

CGS OPEN-FILE 78-2



EXPLANATION

Abandoned well

Gas well

+4382 Top Cozzette Ss.
−357Kd Top Dakota Fm.
(datum mean sea level)

Mesaverde
Mancos

Approximate contact between Mesaverde Group and Mancos Shale

A——A'
LINE OF STRATIGRAPHIC CROSS SECTION
(SEE PLATES 2 AND 3)

Gas field

STRUCTURE MAP ON TOP OF COZZETTE SANDSTONE MEMBER, ILES FORMATION, MESAVERDE GROUP, SOUTHEASTERN PART OF PICEANCE CREEK BASIN

3 2 1 0 3 6 Miles

by H. B. Fender, July 1977

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TYPICAL WELL LOG

DENVER CASPER BILLINGS
DURANGO BISMARCK SALT LAKE CITY

LOC(P.I.)	8 12S 92W
	363 N/S 460 E/W SW SW
CO.	Sunray Mid-Continent
	Oil Company
WELL	#1-C Govt
FIELD	Wildcat
	Delta, Colorado

COLO. NO. 8 12S 92W 03470

SPONTANEOUS POTENTIAL millivolts | CONDUCTIVITY millimhos/m

CRETACEOUS
UPPER
Mesaverde Group
Iles Formation
Williams Fork Formation
Cozzette Ss.
Mancos Shale
Corcoran Tongue
Mancos Silt
Rollins Ss.
Bowie Shale Member
Paonia Shale Member
Undifferentiated Member

RUN 1
RUN 2

R99W R98W R97W R96W R95W R94W R93W R92W R91W R90W R89W R88W

T 6 S
T 7 S
T 8 S
T 9 S
T 10 S
T 11 S
T 12 S
T 13 S

GARFIELD
MESA
DELTA
GUNNISON
PITKIN

RIFLE
GLENWOOD SPRINGS
Rulison
Buzzard
Roberts Canyon
Plateau
Divide Creek
Wolf Creek
Monce Mancos
DEBEQUE
MARBLE
SOMERSET
PAONIA
TYPICAL WELL
Colorado River
Mesaverde
Mancos

EXPLANATION

- Abandoned well
- Gas well
- 28/31 Total coal thickness (ft.), Paonia Shale Member / Bowie Shale Member
- Approximate contact between Mesaverde Group and Mancos Shale (Mesaverde / Mancos)
- Gas field
- Probable coal bed
- Possible coal bed
- 40 Total thickness of coals is in Paonia Shale Member
- 50 Total thickness of coals is in Bowie Shale Member

COMPOSITE ISOPACH MAP OF TOTAL COAL THICKNESS IN BOWIE AND PAONIA SHALE MEMBERS, WILLIAMS FORK FORMATION, MESAVERDE GROUP, SOUTHEASTERN PART OF PICEANCE CREEK BASIN

3 2 1 0 3 6 Miles

by H. B. Fender, July 1977

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